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CONTENTS FOR OCTOBER 1942

Vol. 23, No. 10

EDITORIAL

Objective Synthesis of Our Work

"AG engineers are most useful when they think as engineers and scientists, and act like farmers. They must never lose sight of engineering and science but, figuratively speaking, they should put on their boots and get into the manure pile to find out what use their engineering is going to be to farmers. We must have technical articles and bulletins which are useful to engineers, but I find the best research engineers think definitely and specifically of some type of crop production *as a whole* before they pick out one aspect of it for engineering study."

So said A.S.A.E. Past-President Dr. R. W. Trullinger, assistant chief, Office of Experiment Stations, USDA, in the course of comment on a suggestion that the Society should compile, correlate, and annotate a list of the special bulletins, circulars, etc., issued by the various colleges to help farmers in meeting the quotas and problems of the war effort. The purpose, obviously, is to make such information known and accessible to farmers. Dr. Trullinger believes that such a listing would be useful to many people, but for actual farmers there should be "some focusing or spearheading of information which appears in these bulletins.

"For example, in the corn belt are many 80 and 160-acre farms that should at least be farmed on the contour, most of the fields being too small to terrace. These farms are gradually washing away and losing their usefulness for corn production. Their owners would like to know how to plow, plant, and cultivate such fields on the contour, what equipment is best adapted for the purpose, etc. A one or two-page pamphlet which would tell all about it and make it unnecessary for the farmer to undertake the hopeless job of piecing a lot of information together into one answer would be a great help. . . .

"We have a statement on topping sugar beets, another on planting, another on digging, etc. Right now, in the midst of a sugar and alcohol shortage, sugar beet farmers want to know the best mechanical methods and equipment to *raise a crop of sugar beets* and they want the information *all in one piece*," says Dr. Trullinger among several examples of "anything, in fact, which ag engineers have developed to perform a specific job, *but the whole job . . .*" Horticultural men, agronomists, livestock men, and other specialists are doing this sort of thing, and doing it very effectively in their respective fields, he also pointed out. "How to Feed Broilers to Market Size in Face of a Lack of Milk Mash" is a typical example.

It may not be quite fair to Bob Trullinger to quote these fragments of informal comment. We do it because we believe he states a need and a problem that deserves immediate consideration by the Society and by the colleges, perhaps by federal agencies concerned with effective mobilization of agriculture for food production. This "objective synthesis," as he calls it, would seem to be something for the Society to supervise since no other agency, public or private, is so fully and impartially connected with all the sources of agricultural engineering subject matter.

Actual authorship, with its substantial demands on technical time and energy, and the ensuing costs of publication, should be allocated and assumed among appropriate agencies. The Society can assist with such allocation, to make it equitable and effective. The whole proposal might well be considered at the time of the fall meeting of the Society at Chicago in December.

Inflation by Its Own Name

SPEAKING in simple phrases to earn the ear and the understanding of the masses has its merits, especially from the political standpoint. To dismiss all the other aspects of inflation and imply that "cost of living" comprises the whole problem and the sole peril is a sinister oversimplification. Cost of living always is important, but less so now than in normal or depression times. Today, cost of living is overshadowed by cost of killing. To focus attention on the grocery bill and ignore the war debt we bequeath to our children and our children's children, is to fall something short of statesmanship.

If we accept at face value the propositions that the main cause of inflation is bloated buying power bidding for short supplies of consumer goods, and that the best way to resist inflation is to bleed away the excess of individual income into war bonds and war taxes, we are led to some pertinent but politically unpalatable conclusions.

During the depression we were assured that the sure, quick way to create demand for consumer goods and set the wheels of industry whirling was to drop dollars into the pockets of wage earners. If that was true in those days, despite the influence of sagging markets and panic psychology, it is much more true now under the stimulus of rising markets and war psychology. The realistic remedy for that aspect of inflation is to limit the portion of national income going to pockets where it burns until disposed of on the dollar-down, dollar-a-week basis.

Likewise, the way to get more of the national income invested in war bonds and recaptured in war taxes is simply and obviously to channel more of the national income into pockets of the people who spend the smallest percentage of their earnings on consumer goods and invest the largest percentage in securities akin to war bonds; also to the same or other people who pay high percentages of income in federal taxes.

Obvious as all this is, it will not appeal to those who look on the war as an opportunity to revise the social order and redistribute the nation's wealth. For precisely that reason these considerations demand redoubled emphasis by those of us who feel that America's job is firstly to win the war and secondly to pay for it. No doubt many of the men in public life see these things as clearly as do the men in engineering, but are deterred from dwelling on them. We can fortify their convictions by making ours known.

Baruch and His Bench

WHEN Bernard M. Baruch was appointed as head of the committee to report and recommend with respect to rubber, there were press stories saying that there had been no pretentious office for him, and that he had been doing his heavy thinking on a bench in a Washington park.

After comparing his committee's report with other edicts, exhortations, and explanations emanating from that city, we are firmly convinced that what Washington needs is more parks, more benches, and fewer offices. If not that, there should be more men with the courage, candor, the intellectual honesty, and the instinctive Americanism which are the character of Bernard M. Baruch, Karl T. Compton, and James B. Conant.

About the only criticism we can make of the report is that one of its most pointed and vital recommendations was ignored.

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VOL. 23 OCTOBER 1942 NO. 10

How to Increase Farm Production with Reduced Man Power

By D. A. Milligan

MEMBER A.S.A.E.

THERE are five things that can be done to increase farm production with reduced man power. They are:

1 Reduce man labor per crop unit
2 Reduce number of operations performed in the producing of crops
3 Work more hours per day, more days per week, more days per month, and more days per year
4 Have a well-organized and diversified system of crop and livestock production with a distributed labor requirement
5 Raise maximum yields.

To secure maximum production with reduced man power and at the lowest possible cost will require the practicing of all five of the above factors. Labor and power are two of the major costs in crop production. Tractor-hours and machinery-hours are quite closely related to man-hours. The reduction of man-hours in most cases will reduce tractor or horse-hours; thus any reorganization that can increase production and reduce the man power will automatically reduce the cost of production.

Regardless of anticipated better prices and greater demands, the successful, efficient farmer will still try to lower his cost of production. Lowering production cost will increase profit margin, and it will place the farmer in a position to pay taxes, reduce outstanding indebtedness, and put himself in a liquid position.

Reduce Man Labor Per Crop Unit. To secure the maximum output per unit of labor makes necessary the maximum utilization of labor-saving machinery. The tractor should be worked with the largest load back of it that it is capable of handling, even though it may be necessary to operate in one lower gear. More work will be performed at a lower cost for fuel and with less damage to the drawn implements and to the crops, and with less total wear on the tractor and implements by operating with a larger load and at a slower speed, than by operating with a small load and at a higher speed. The use of combinations of implements, performing several operations at one trip over the field, will reduce man labor in relation to the work performed. Using a leveling spiketooth harrow in combination with a disk harrow, thus eliminating one harrowing operation, will reduce the labor in raising 140 acres of corn by 2¾ per cent.

The utilization of a weeder mounted on the tractor in conjunction with a cultivator will eliminate at least one cultivation. In raising 140 acres of corn, the elimination of one cultivation will reduce the man-labor requirement by 10.6 per cent. If by use of a small section of a spike-tooth harrow in conjunction with the moldboard plow it was possible to eliminate one harrowing, it would reduce the man labor required in raising corn 2¾ per cent.

The building of a small tandem disk harrow, that is, taking an old harrow and reducing it to such a width that it will cut the furrow slices being turned and pulling it in conjunction with the plow, will reduce the man labor 7.7 per cent. This is on the basis of eliminating one disking in the raising of a corn crop.

The working of combinations of implements today offers great possibilities in the reduction of man labor required to produce crops; it will insure the maximum load back of the tractor and it is a method that can very easily be put in operation. Most farmers with a little ingenuity in the development of hitches can make combinations out of the tools they now own and operate.

A weeder mounted on a tractor, in addition to the cultivator attachment will eliminate at least one cultivation

To reduce man labor requires the use of the maximum sized machinery that the operation will justify. Under present conditions, with the military service having the first demand on all manufacturing facilities, material, etc., very few new tractors or new implements will be available to replace those that are normally replaced, and very few new tractors and implements will be available for the increased work necessary to meet the accelerated demand placed upon the farmers of the United States to feed the world. Those farmers whose tractors have excess power for the implements that they are using should buy an extra bottom for their plow, a wider disk harrow

Paper presented June 29, 1942, at the 35th annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis. A contribution of the Power and Machinery Division. Author: Equipment sales engineer, Cleveland Tractor Company.

if the tractor is capable of handling it, or a weeder to use in conjunction with their cultivator, and trade in their undersized implements. Then they should operate a larger acreage.

Frequently, by the exchange of allied tractor equipment through the local farm implement dealer or between individual farmers, they can secure better balanced and sizes of equipment for their tractors. Where new implements of larger capacities cannot be purchased or traded for, the same results can be achieved by combination hitches.

It is still going to take many bushels of corn or wheat, even at the increased prices, to pay for tractors, implements, and machinery. Farmers who buy additional machinery should increase their crop acreage to justify equipment. To utilize labor-saving machinery economically and to keep the investment per crop unit to a minimum requires a volume of business. Every farmer owes it to himself and to his country to work the maximum acreage that his equipment can handle. Where the capacity of his equipment is greater than his acreage, he should either rent additional acreage or, in event such acreage is not available, he should do custom work.

Reduce Number of Operations Performed in Producing Crops. By proper planning, organization, and performing of operations at the optimum time, frequently certain operations in the production of crops can be eliminated without affecting the yield. To raise 140 acres of corn to harvesting time with a two-plow tractor, disking the ground twice (once before and once after plowing), plowing, harrowing twice with a spiketooth harrow (one prior to and once after planting), and planting and cultivating it four times, will require 723 man-hours of labor. If this operation is carried on with a two-plow tractor and by working long hours, this can be done. The tractor-hours will be the same as the man-hours. Thus any reduction in man-hours will reduce tractor-hours and the operating cost, both for labor and power.

MAN-HOURS REQUIRED TO RAISE 140 ACRES OF CORN WITH TWO-PLOW TRACTOR

Operation	Man-hours	Number of times over
Plowing	186	1
Disk harrowing	112	2
Spiketooth harrowing	39	2
Planting	77	1
Cultivating	309	4
	723	10

	Total man-hours	Hours saved	Per cent time saved
Elimination of one disking	667.0	56.0	7.7
Elimination of one harrowing	703.5	19.5	2.7
Elimination of one cultivation	646.0	77.0	10.6
Elimination of two cultivations	569.0	154.0	21.2
Combination of one disking and harrowing	703.5	19.5	2.7

By the elimination of one disking, as previously discussed under combinations of equipment, we will reduce the man-hours and tractor-hours required to produce 140 acres of corn by 56 hours. This is a saving of 7.7 per cent man labor. If by using a leveling harrow in conjunction with the plow we could eliminate one harrowing operation, or if by the proper preparation of the seedbed we could eliminate one spiketooth harrowing operation, we would reduce the labor requirements by 19½ hr, or 2.7 per cent.

Obviously the type of soil, the crop that was on it previously, and the weather conditions are going to have an effect upon whether either of the above operations might be eliminated; however, if by a combination disk and leveling harrow you eliminate one harrowing operation, you are directly effecting a saving of 2¾ per cent of the man labor and power required. We would strongly urge that under no conditions should a seedbed be improperly prepared merely to effect a saving of labor in its preparation.

A good seedbed is the first prerequisite to a good yield. A few bushels of corn per acre, or soybeans or oats, will more than justify the expense of the additional labor and power which may be required in getting the seedbed into good condition.

In the preparation of a seedbed for corn, soybeans, and other cultivated crops, an extra fitting operation properly spaced will do more to control weeds than several cultivating operations at a later date.

The one operation in the production of corn, soybeans, potatoes, and other cultivated crops that offers more opportunity for the reduction of man labor than anything else is by the use of a weeder in combination with a cultivator, particularly on those crops which are cultivated with sweeps. I believe it is universally agreed that the primary reason for cultivation is to control weeds. By the utilization of a weeder mounted and operated on the tractor in conjunction with the cultivator, in a normal season, at least one cultivation can be eliminated. The sweeps cut the weeds, and the weeder levels the ground, pulls out the weeds so they will be exposed to the sun, and restores a mulch on the surface. If by the use of a weeder in the cultivation of corn you will eliminate one cultivation, assuming you were going to cultivate it four times, you would reduce the man labor needed to raise corn by 10.6 per cent. If it is possible to reduce it to two cultivations instead of three, you will reduce labor requirements 21.2 per cent. Probably the elimination of two cultivations by the use of a weeder would be too optimistic; however, assuming the crop was going to be cultivated three times, you would effect a saving of 12 per cent in labor requirements, by eliminating one cultivation. By an analysis of the operations needed to prepare the seedbed and cultivate most crops certain operations can be eliminated.

It would seem a very timely and worth-while extension project for agricultural engineers to start holding meetings, discussions, etc., to get the farmers thinking along the lines of eliminating certain operations by combinations of equipment and operations, and by the utilization of the proper type of equipment at the proper time.

Work More Hours Per Day, Etc. There is a definite shortage of man power, and the easiest method to compensate for it is to work longer hours and more days per week and per month. There is a definite limit as to the number of hours a man can work effectively and efficiently per day. There are two distinct peak demands for man labor and power in agricultural operations. These peaks come during the seedbed fitting and planting period and during the harvest period.

During these peak periods tractors and equipment must be run the maximum number of hours that the operator or operators are capable of driving them. To operate the modern tractor and implement requires very little physical effort. Regardless of this fact, the noise, confusion, vibration, and dust all contribute toward operator fatigue. There are certain things which can be done to all tractors that will make the operation of them less tiring. One is fitting the tractor with a muffler. The roar of the exhaust and the barking of the motor may be thrilling during an

8-hour day, but after riding a tractor for 12 to 16 hours it becomes very noisy, irritating, and tiresome.

Money invested in mufflers on tractors is well spent and will reduce operator fatigue. Care should be taken that the exhaust is discharged in such a direction that the wind will not blow it back into the operator's face. Carbon monoxide and other fumes of the exhaust will tire an operator and in many cases make him sick. All tractors should be equipped with umbrellas or some type of top to protect the operator from the sun. Many farmers feel they can take it without protection; however, they can take it better and longer if they ride in the shade.

There are available certain accessories that ease the strain on tractor operators. Some of them are made by the tractor manufacturer, some by accessory manufacturers, and some are homemade appliances. A few that are particularly pertinent are (1) furrow guides when plowing, (2) swinging markers or guides that indicate the position of the tractor with reference to the previous passes through the field, and (3) door springs or checks on the steering wheel which holds the tractor against the furrow wall. All of them take some of the strain off the operator and permit his moving and changing his position on the tractor.

Certain companies can supply spring and other types of padded seats. Anything which will relieve the strain on the operator and make riding more comfortable will enable the operator to work more hours efficiently. Where the tractors are going to be operated at night, they should be fitted with good adjustable lights, both fore and aft. These should be adjustable and they should be placed in such position as not only to illuminate the ground in front but they must also illuminate the implements and the work which the implements are doing.

A Well-Organized and Diversified System of Crop and Livestock Production. By diversifying crops and selecting those whose seeding and harvesting dates occur at different times, it is possible to distribute labor requirements and reduce peak power and labor demands. The reorganization of the crops being raised to permit leveling off of the labor and power demands will permit greater production in that it gives more uniformity to the labor required each day. The lend-lease program and the food-for-defense program for 1942 show definite increases for pork and its allied products, for dairy and poultry products, and numerous kinds of vegetables.

Livestock production is ideally adapted to the distribution and leveling of labor requirements. Diversified crops and production reduce the hazard of crop failures. They permit marketing through livestock a large portion of the farm crops. It keeps the fertility on the farm. It keeps the cost of delivering the feed to the market on the farm as a profit.

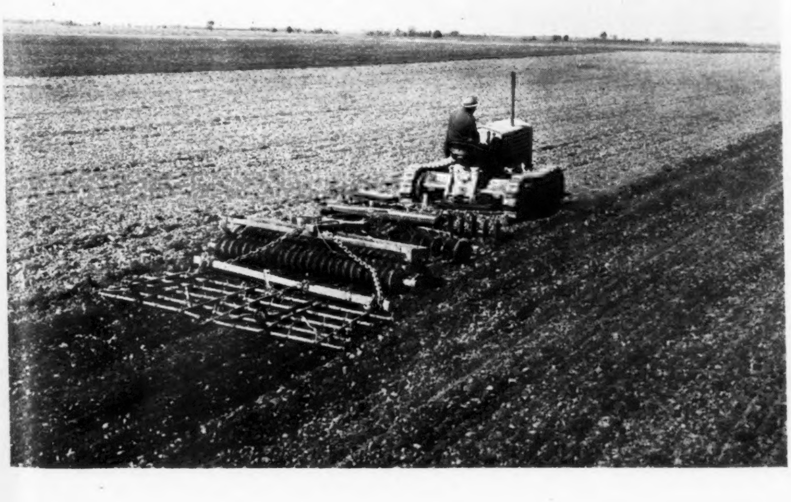
The proper diversification of crops and livestock may eliminate harvesting in its entirety. I particularly refer to the hogging down of corn and soybeans, the running of sheep in corn, the harvesting of hay and other grass or forage crop by pasturing with sheep, hogs, or dairy or beef cattle.

Raise Maximum Yields. One of the most important factors in increasing farm production in relation to man power is large yields. Other than the cost of harvesting the crop, the labor requirements, the power requirements, and also the equipment expenses are the same for large yields as for small yields. Increasing the yield from 40 to 60 bushels per acre will reduce the man labor per bushel of corn produced over 30 per cent. There is no other factor as important in reducing man power in relation to the crop produced as higher yields. Extreme care should be taken so that farmers do not become over optimistic as to the acreage they can handle. They must have sufficient power and equipment to prepare the seedbed at the proper time, so as to have it in the optimum condition to utilize available moisture, in cases of wet seasons to control weeds, and to plant at the correct time and properly care for the crops.

In event of adverse seasons, it is better to leave certain of the land idle than to prepare, seed, plant, and tend a larger acreage poorly which, under those conditions, may result in crop failure or low yields and poor quality. Statisticians tell us that at the present time there is a shortage in excess of one million men on farms, a shortage which is going to be further increased as our war program expands.

The Farm Equipment Institute advises that the increased demand for farm products this year requires 605,000 more men than were on the farms during the average of the last five years. To win the war our armies must be fed, and our war workers and our allies must eat. America has the acreage and the fertility of farm land to do this. For the farmer to produce the food requires a reorganization and a readjustment in power machinery and in farming operations. To meet the present demand requires the maximum output per unit of labor and this requires maximum utilization of labor-saving and power machinery.

It is one of the most vital problems in our war program. It is a challenge to agricultural engineers —it is our problem, and I am certain that our college agricultural engineering departments and extension staffs, and all members of our Society are capable of meeting this challenge.



If by a combination of disk harrow, soil packer, and spiketooth harrow, like that shown in this picture, one harrowing operation can be eliminated, then a saving of at least 2¾ per cent in man labor and power can be effected

The Production of Guayule Rubber Under Irrigation

By G. E. P. Smith
MEMBER A.S.A.E.

ONE of the most critical exigencies confronting the Allied Nations, including America, arises from the abrupt and practically complete shutting off of the supply of natural rubber. There will be comparatively little rubber available from South America, due to the leaf-spot fungus disease, the difficulty in gathering wild rubber, the lack of trained and willing labor, and the needs for rubber of South American countries themselves. Of the guayule, or wild shrub, rubber produced in Mexico, a considerable part will be fabricated in the two plants in Mexico City. That production will exceed 6,000 long tons this year, about 50 per cent more than in 1941.

The Intercontinental Rubber Company has taken the leading part since 1905 in the production of rubber from guayule shrub. The domestication of guayule was begun in 1911 by that company near San Diego, California, when finally the difficulties of seed germination were overcome by Dr. W. B. McCallum, a plant scientist. During the next few years the cultivation problems were solved and the adaptability of guayule as a farm crop was demonstrated. By 1916 the Intercontinental Rubber Company was ready to begin the production of guayule rubber on a commercial scale.

After prolonged search a location 25 miles south of Tucson, Arizona, was chosen. Part of a Spanish land grant was purchased, which included 4,000 acres of tillable, irrigable land. The soils of the tract are of two general types, about equally divided: the soft loamy soils of the Santa Cruz River flood plain and the sandy or gravelly loamy soils deposited by tributary washes mostly on small delta fans. Both types of soil proved to be satisfactory. Water for irrigation was obtained from wells; drainage was not needed. The land was cleared of mesquite trees, blocked out into fields and leveled. Windbreaks of the native mesquite were left. Thirty miles of cement-pipe distributaries 8 to 20 in in diameter were installed. The author was the company's engineer from 1916 to 1922.

Operations were slowed by the small seed supply and nursery operations. A four-row partially automatic planter was designed and built to set the year-old nursery plants in the field in rows spaced at 2½ to 3 ft and 2 ft apart in the row. The plants, irrigated and cultivated like other row crops, thrived and made good growth; many rows 1,000 ft long had not a single plant missing. For the first few irrigations, broad cultivator sweeps were needed to make wide shallow furrows so that the water would seep to the roots of the little plants. Thereafter, when the plants were well rooted, the irrigations were timed according to the soil type and the moisture depletion, not differently from the irrigation of cotton and other row crops.

The plan was to irrigate the fields two years for maximum growth (and tonnage), and then to starve the plants for water for two years to force and accelerate the synthesizing of rubber in the tissues, mostly in the phloem. Probably as experimental results accumulated, this plan would have been modified to a tapering off of irrigation the second and third years, depending partly on the extent of the seasonal rainfall, sacrificing growth more and more to increase the percentage of rubber. The drying-out periods might begin in the fall of the second year and occur possibly twice in each of the third and fourth years. Harvest could be made after the third or any later year.

However, when the first planted fields were in their third year, the price of Sumatra and Ceylon rubber dropped precipitously, far below the cost of producing guayule rubber, and operations such as weeding and irrigating were suspended. The contemplated mill was not constructed. After two years of watchful waiting, during which the outlook grew darker, the project near Tucson was abandoned.

Unwilling to give up entirely, the company moved to a new location in the Salinas Valley of California where the cheaper rain and fog could (Continued on page 324)

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Views of the U.S.D.A. Forest Service emergency rubber project at Salinas, Calif. • Left: General view of the guayule nursery showing the last block being sown and sprinkling following immediately after sowing • Right: Topping guayule seedlings preparatory to transplanting (Photographs by courtesy of the Forest Service of the United States Department of Agriculture)

Developments in Fruit Dehydrator Design

By Rene Guillou
MEMBER A.S.A.E.

FOR many years dried fruit has been one of the major farm products of California. Perhaps half the total production is dried artificially, the balance being dried in the sun. Artificial drying is gaining ground because it requires less labor, is independent of weather conditions, and insures a better product. Dehydration of vegetables is an acute problem at the present moment because of the demand for extreme compactness in overseas' shipment, and because of the shortage of tin for cans. The dehydrators in use are comparatively large and expensive units costing several thousand dollars to construct, and capable of handling the production of fifty acres or more of a single crop. These conditions have led to an insistent demand for a smaller unit, with a first cost and capacity to appeal to an operator with twenty acres or less in a single crop, yet capable of producing a high quality product with a minimum of labor.

Although many types of dehydrators are in use, the trend in the past two decades has been toward a counterflow tunnel, usually 6 or 8 ft wide, 7 ft high, and 25 to 50 ft long. The produce is placed on wooden trays which are in turn loaded on small cars and fed into one end of a tunnel. Heated air is blown through the tunnel in the opposite direction, usually by an electrically driven fan. At the cold end of the tunnel a part of the air is discharged to the atmosphere; the balance is reheated and recirculated, the proportion depending on the product. If the material dries slowly and the air is quite hot, as is the case with partially dried fruit, discharge of 5 per cent of the air being circulated may be sufficient to keep the humidity in the dehydrator down to 35 per cent. If the air temperature is low, however, as in drying rice or walnuts, it may be most economical to discharge all of the air, using it only once.

Many dehydrators now operating satisfactorily have been constructed according to successful practice rather than from a calculated design. Observation and experience make possible an approximate proportioning of furnace and fan to size of tunnel and character of product. If any part of the design is inadequate, it is replaced; if it is oversize, it serves its purpose and no one is the wiser.

An engineer wishing to calculate his design has been obliged to begin by assuming tunnel dimensions, temperatures, and humidities in accord with good practice. He estimates the drying time from experience with comparable installations. A heat balance is then used to calculate the volume of air circulation necessary to maintain the assumed temperature, and a mass balance gives the air discharge necessary to maintain the assumed humidity. Heat loss in the air discharge and through the walls can be calculated and added to the heat used in evaporation in order to obtain furnace load. This design procedure was described by A. W. Christie and G. B. Ridley[1] in 1923, in an article which after 19 years remains a classic. Fans and furnaces selected in this manner are correctly proportioned to their loads, and the dehydrator should perform as predicted, provided the drying time has been correctly estimated. The design is, however, based on assumed tunnel dimensions; and a question may now be raised as to whether the usual tunnel dimensions are the most efficient.

Consideration of this problem leads to the conclusion that an advance in design methods, or such a departure from convention as is involved in the development of a small unit, must be based on a quantitative relation between drying time or rate on the one hand, and conditions in the dehydrator on the other. So long as performance of a design is based on an assumed drying time, there can be no intelligent determination of the effect of air velocity, temperature, or other factors on capacity of the unit. On the other hand, given a quantitative relation of drying rate to air velocity, for example, it is possible to calculate an optimum air velocity. Use of a higher velocity uses fan power in excess of the savings effected by more rapid drying; use of a lower velocity does not save sufficient fan power to offset the losses from slower drying.

Measurements of drying rates of prunes have been car-

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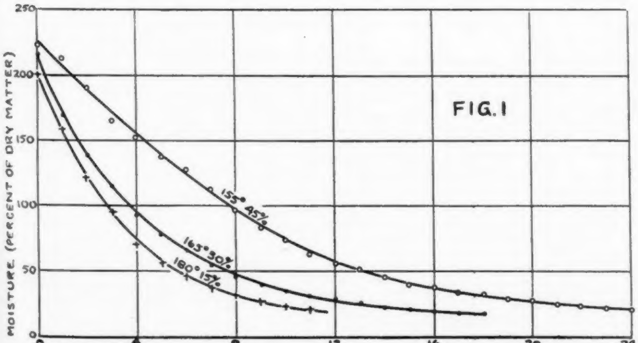
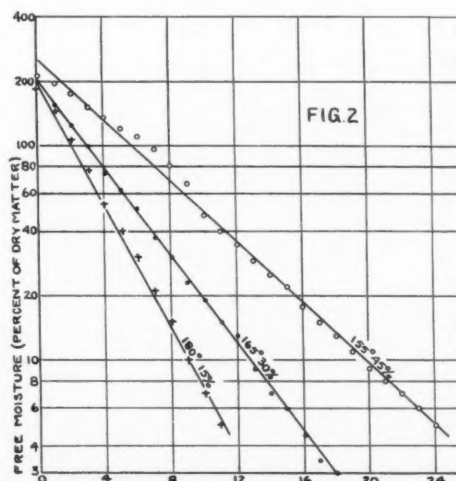
[1]Christie, A. W., and G. B. Ridley, "Construction of Farm Dehydrators in California," 1923 Transactions of the American Society of Agricultural Engineers.

Fig. 1 Typical drying curves in which moisture content is plotted against time • Fig. 2 Curves in which free moisture is plotted against time on semilog paper





ried on at Davis for the past two seasons with a view to obtaining quantitative relations among dehydrator conditions, drying rates, and quality of product. A small wind tunnel was constructed for the purpose, provided with means for controlling and measuring the temperature, velocity, and humidity of the air. The drying section holds 400 prunes, of which 100 are a source of samples to be used as a check on moisture content. The remaining 300 are weighed hourly to determine drying rate, and furnish samples for final determination of moisture content and appraisal of quality. Over eighty lots have been dried in all, including prunes from various localities and of various varieties subjected to sundry pretreatments and dehydrator conditions.

Fig. 1 shows typical drying curves, in which free moisture, expressed as a percentage of dry matter, is plotted against drying time. Prunes with a moisture content of about 16 per cent are in equilibrium with the air in a dehydrator; moisture in excess of this amount is considered as free. When free moisture is plotted against time on semilog paper, as in Fig. 2, these curves become approximately straight lines. This indicates that drying rate is proportional to the free moisture present.

Letting W = free moisture (per cent of dry matter)

Θ = time (hours)

K = a drying coefficient (1/hr),

$$\frac{dW}{d\Theta} = -KW, \text{ and by integration}^2 \quad \Theta_2 - \Theta_1 = \frac{1}{K}\, ln \frac{W_1}{W_2}$$

The coefficient K, which is the slope of the lines in Fig. 1, may thus be calculated from any observed drying time and initial and final moisture content. The value of the coefficient evidently depends on air conditions and character of the fruit. If the coefficient can be predicted for proposed conditions, it becomes possible to calculate drying rates and times instead of estimating them.

Fig. 3 shows calculated values of the drying coefficient for runs at varying temperatures, other conditions being constant. The drying coefficient is seen to vary quite closely with the fourth power of the Fahrenheit temperature. The relation of drying coefficient to air velocity is shown in Fig. 4. The number of runs here is smaller and the results are less consistent. Variation of drying rate with two-tenths power of air velocity appears, however, to be a satisfactory basis for design work. This rather minor effect of air velocity on drying suggests that resistance to internal diffusion is a major factor, and that those external conditions which affect the temperature of the fruit are the most important. It is to be noted that in this case velocity varies while other factors remain fixed. In the usual dehydrator a variation in air velocity also changes air temperature at the cold end of the charge, which has an important effect on drying rate.

In Fig. 5 drying coefficient is plotted against relative humidity. At relative humidities of 40 per cent or less, resistance to internal diffusion appears to be controlling, and humidity is without effect. At higher humidities, external resistance becomes important and the drying coefficient is roughly proportional to 100 minus the relative humidity. These empirical relationships are much simpler than the quite complicated physical situation, and additional analysis or observation may modify them, but for the present they seem adequate for design work. They may be summarized by the formula

$$K = 0.20 \left[\frac{t}{165}\right]^4 \left[\frac{v}{600}\right]^{0.2} \left[\frac{100-H}{60}\right]$$

in which for $H<40$, $(100-H)/60$ is taken as 1, and where

t = air temperature (deg F)

v = air velocity (fpm)

H = relative humidity (per cent)

We may now turn to the possibilities in design work opened up by the use of such a formula for the drying coefficient. The following discussion deals immediately with a drier for prunes, but the applicability of the methods to other products will be obvious.

As drying rate, and with it the daily capacity of the drier, vary with the fourth power of the temperature, it is evidently desirable to use the highest maximum temperature that will not damage the fruit. There appears to be a steady lowering of quality with increase in temperature, throughout the range in which dehydrators are usually operated, so that it is necessary to make a somewhat arbitrary compromise between fast, economical drying and maintenance of top quality. Apparently a maximum air temperature of about 165 F is most desirable for prunes under present conditions.

Considerations involved in choosing optimum air veloc-

[2]For a complete analysis see Walker, Lewis, McAdams, and Gilliland, "Principles of Chemical Engineering." McGraw-Hill, 1937.

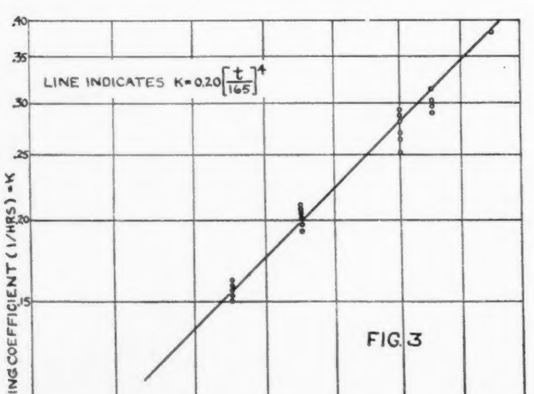


Fig. 3 Drying coefficient plotted against air temperature

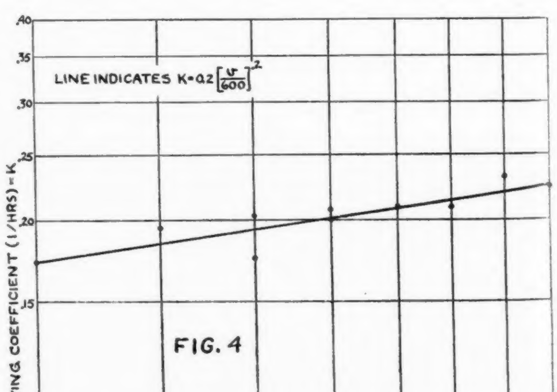


Fig. 4 Drying coefficient plotted against air velocity

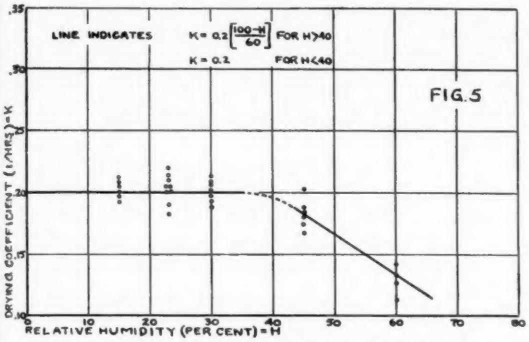


Fig. 5 Drying coefficient plotted against relative humidity

ity and optimum air circulation are sometimes confusing to those accustomed to thinking in terms of assumed tunnel dimensions. To visualize the relation of air velocity and volume to each other and to air horsepower and drying rate, let

v = air velocity in gross section of charge (fpm)
S = gross section of charge (sq ft)
L = length of charge normal to section S (ft)

Then

Volume of air circulated $= S\,v$
Static air head across charge $= C_1\,L\,v^m$, where C_1 and m are experimentally determined constants.

Using a common formula

$$\text{Air horsepower} = \frac{(S\,v)\,(C_1\,L\,v^m)}{6{,}356} = \frac{C_1\,L\,S\,v^{m+1}}{6{,}356}$$

It is important to note that air horsepower is here expressed as a function of v, the velocity; and of the product $L\,S$, which is the volume of charge. The charge section S may be changed, and with it the product Sv, which is the volume of air circulated; but air horsepower will not be affected if charge volume and air velocity do not change. In other words, for given charge volume and air velocity, air horsepower is fixed and will not be affected by air volume.

Returning to the expression for air horsepower, if A_1 is the annual fixed and operating charge for the fan installation per air horsepower, then

$$\text{Total annual fan cost} = \frac{A_1\,C_1\,L\,S\,v^{m+1}}{6{,}356}$$

Assuming the annual fixed charges on the plant, excluding fan and motor, to be proportional to cubic capacity, which is approximately true; then annual structure cost $= A_2\,L\,S$, where A_2 is the annual fixed charge per cubic foot of capacity.

Since annual capacity depends on volume of charge and drying rate, annual capacity in tons $= C_2\,L\,S\,v^n$, where C_2 and n are constants.

We may now combine these expressions

$$\text{Combined cost per ton} = \frac{\dfrac{A_1\,C_1\,L\,S\,v^{m+1}}{6{,}356} + A_2\,L\,S}{C_2\,L\,S\,v^n} = \frac{\dfrac{A_1\,C_1\,v^{m-n+1}}{6{,}356} + A_s\,v^{-n}}{C_2}$$

For minimum cost the first derivative may be equated to zero

$$\frac{(m-n+1)\,A_1\,C_1\,v^{m-n}}{6{,}356} - A_2\,n\,v^{(-n-1)} = 0$$

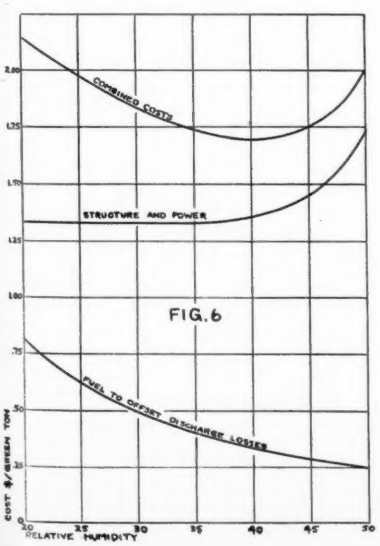
$$v = \left[\frac{6{,}356\,A_2\,n}{(m-n+1)\,A_1\,C_1}\right]^{\frac{1}{m+1}}$$

Substituting constants applicable to drying prunes in California, under average conditions

$$v = \left[\frac{6{,}356\,.\,0.23\,.\,0.2}{(4/3-0.2+1)\,.\,50\,.\,(5.4\,.\,10^{-6})}\right]^{\frac{1}{\frac{4}{3}+1}} = 280 \text{ fpm}$$

Different relative costs for plant and air circulation would change this optimum velocity considerably. It appears that the common values of 600 fpm and upwards are usually too high, however.

Fig. 6 shows a graphical solution for optimum relative humidity. Humidity in the drier depends on the proportions of air discharged and recirculated. Decreasing the pro-



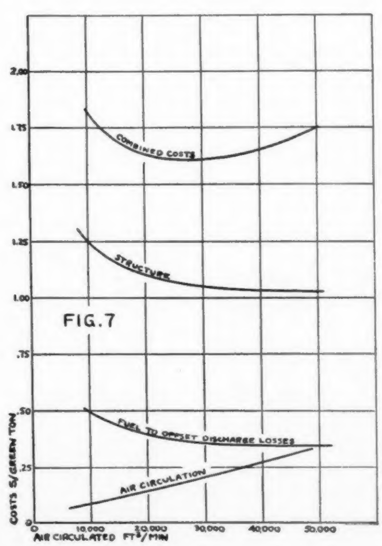


Fig. 6 Choice of relative humidity. Temperature of outside air, 65 F. Temperature of discharged air, 150 F • Fig. 7 Choice of volume of air circulation. Charge 864 cu ft, equal to 3,200 lb dry matter. Initial temperature, 165 F. Air velocity, 260 fpm

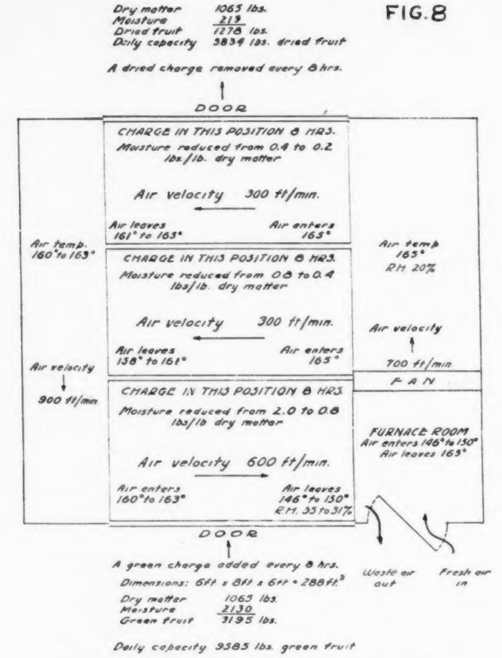


Fig. 8 Flow plan of a proposed 5-ton dehydrator

portion of air discharged also decreases fuel cost, but a point is reached where rising humidity slows down the drying and other costs rise rapidly.

In Fig. 7 the effects of varying volume of air circulation are plotted. As pointed out above, larger volume of circulation does not affect air horsepower if it is accomplished by increased charge section, with constant velocity. On the other hand, increased circulation requires larger ducts, and the fan must be larger and more costly, even if no more power is needed to drive it. A straight line relation is used to approximate these increases in cost.

As we are considering an increase in volume to be accomplished by retaining constant air velocity while increasing the section of the charge and reducing its length, it is evident that the increased volume will be accompanied by higher temperature at the cold end of the charge. This increases the moisture-carrying capacity of the discharged air, and so reduces fuel cost. Higher average temperature also accelerates drying and thereby reduces structure costs. The curves in Fig. 7 were obtained by calculations for three trial values of air volume.

TABLE 1. PRUNE DEHYDRATOR DESIGNS

Conditions	Ideal	Test plant	Usual practice
Maximum temperature (deg F)	165	165	175
Air velocity (fpm)	280	300-600	600
Air volume per ton charge (cu ft/min)	5,600	4,300	2,250
Drying time (hr)	26	24	24
Air horsepower per ton charge	0.1	0.2	0.5
Heat loss in discharge (%)	22	30	35

It now remained to embody the ideal values of temperature, air velocity, humidity, and air volume in a workable unit. This has been done, and it is hoped to have construction of a test plant under way at the time this paper is presented. The results in Table 1 may be of interest. We hope that we have designed a small unit that will cost no more per ton of capacity to build than the larger plants, that will use somewhat less fuel per ton, and much less fan power per ton.

The short air path of large section, which is desired for the conditions of maximum efficiency indicated in Table 1, may be approached by using air flow transverse to the progress of fruit through the dehydrator, as indicated in Fig. 8. This causes one side of the charge to be drier than the other, unless the air flow is reversed at the proper time to equalize the moisture content by the time the fruit is removed. In fact, this appears to be the only practicable means of securing even drying in a small unit, in which the amount of charge added at any one time is large enough in relation to the whole to be subject to an appreciable higher temperature at the point where the air enters it than where the air leaves it.

There appears at this point a problem of interest to those with a fondness for mathematical analysis, namely, the calculation of conditions in the interior of a drying charge. Change of air temperature with respect to position in the charge is a function of change of moisture with respect to time; and change of moisture with respect to time is a function of temperature and moisture content, both of which are variables. Happily humidity varies but little and may be considered a constant. An analytical solution for conditions in the interior of the charge during the drying process appears to be impossible, but a step-by-step calculation is not difficult, and may be used to predict the performance of a proposed flow plan. Fig. 9 shows the results of such a calculation for the flow plan of Fig. 8.

While this paper has dealt primarily with the drying of prunes, a similar method could be used in working with any other product. The steps involved may be reviewed as follows:

1 Drying samples of the material under various conditions, and deduction of empirical expressions for drying rate in terms of the variables involved

2 Separate development of the optimum value for each of the variables that is controllable

3 Embodiment in a design of the closest practicable approach to these optimum values.

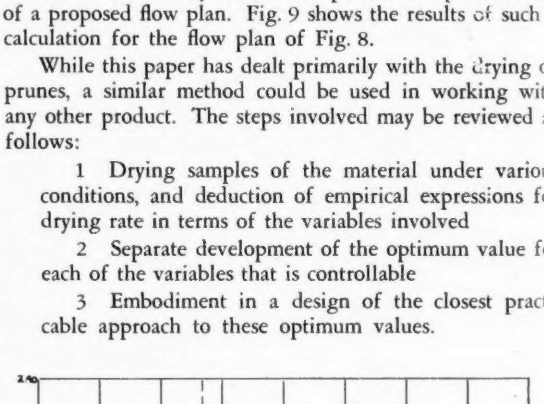


Fig. 9 Calculated conditions in drying charge, initial moisture normal. Relative humidity, 35 per cent. Charge density, 3.5 lb dry matter per cubic foot

The Integration of Farm Equipment into the War Effort

By Frank J. Zink
MEMBER A.S.A.E.

THE integration of agricultural engineering into the war effort should be effectuated through the key factors of food production, land, labor, and equipment. By equipment I mean any apparatus, including power sources, which is functional in the production of food, fiber, or oil crops. At the outset the application of agricultural engineering principles to combinations of land, labor, and equipment is an indirect procedure differing from the direct practice used in structures, land improvement, or factory.

The engineering principles incorporated into a machine are applied by a farm operator who may never have heard of the engineer and who may reside on the opposite side of the earth. Engineered ideas in conjunction with management of equipment in its functional application may also be remotely conceived. This remoteness of the direct relationship of the engineer to the job, inadequate analysis, and unsatisfactory checks on the results obtained are primary weaknesses of the profession. These weaknesses when coupled with the broad scope of types of agricultural production, the social strata of the people involved, and the number and intelligence of farm operators, mean that in war or in peacetime the profession is no fool's paradise for the sport of amateurs. It should be emphasized that the utmost in critical analysis and the most valid engineering principles must be united or the profession may be buried along with its mistakes. This goes double for agricultural engineering in a war effort.

This is pointed out because we have some notable cases of the absence of a sound engineering approach to our work in food production. The application of sound engineering policies to food production will gain for our country those things which are needed to win this war. Ample food with decreased manpower is possible provided the supplies of production are sufficient for the task.

The question might well be considered: Were it not for the agricultural engineer, where would we stand in our ability to conduct this war? We likely could not supply as much food under the lend-lease plan to the United Nations. Agriculture could not supply as much manpower to the armed forces and to war industries. We could not anticipate writing as strong a peace as we have the right to expect. All these are partially the contributions of the agricultural engineer which have already been integrated into the war effort.

The area of land in the United States under cultivation is a direct function of the productivity of the land and the number of people to be supplied with the produce. The land area required to fulfill domestic requirements has been comparatively static for many years. It has never varied more than 10 per cent above or below 2 acres per capita of harvested crop land in the last thirty-year period. Fig. 1 is a graphic record of this fact, while Fig. 2 shows the use of harvested crop land whether for animal power needs, domestic food needs, or for export food requirements[1]*. Engineering analysis indicates that it is improbable to expect human nature to couple our war effort with a boost in productive efficiency to a point where we can add lend-lease food requirements to domestic food requirements without the expansion of land area in crops. Early in the 1942 food program this was considered possible[2] but obviously things have changed particularly with Pacific area imports and ship space limitations.

Such acreage expansion becomes an engineering problem calling for extension of operations with labor and equipment. In doing so we must avoid some of the mistakes of World War I when we broke land thought to be productive, reduced grassland farms to grain farms, and in general disturbed much of the economy established by years of practice. The inevitable reaction to reconsolidation has led some of the statistical minded social scientists to point with scorn to the agricultural engineer, with the words "farm machinery is wrecking family farm units and farms

Paper presented July 1, 1942, at the 35th annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis. Author: Director, research department, Farm Equipment Institute.

*Superscript numbers indicate references appended to this paper.

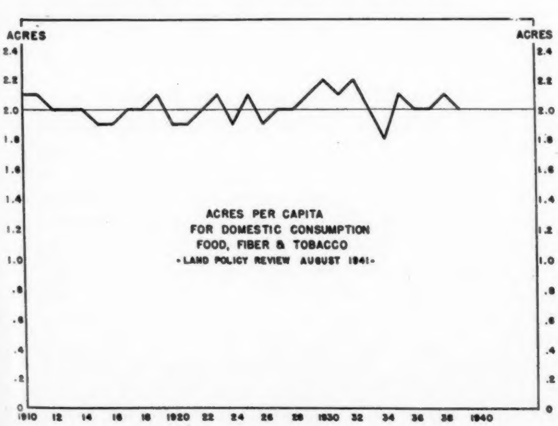


Fig. 1 Harvested crop acres per capita

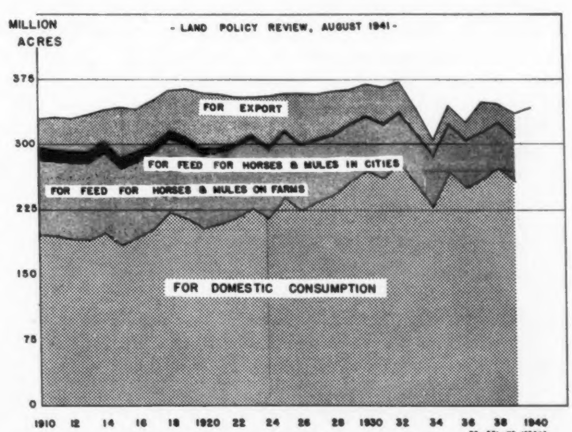


Fig. 2 Harvested cropland used for specific purposes

are being made into food factories and ever growing larger." They so state even though more thorough analysis of matters beyond statistics indicates the collective fare of the enlarged farm provides, under methods of management of marginal land, no more than decent living for a single family.

Incidentally, according to the 1935 census, all the 88,662 farms in the group above 1,000 acres utilized for crops an average of 338 acres of the total average land area of 3,493 acres in each. These farms lying in marginal areas would probably not equal the productivity or income potentialities of an average corn belt farm. This would not indicate the demise of family farming. However, if care is not taken in the enlargement of land operations, we shall again have a period when the agricultural engineer is put on the defensive.

In respect to labor and employment in agriculture we are now advancing into the qualitative stages of farm employment. If the most recent report on farm labor[3] is indicative, our quantitative downward trend of persons employed is now reversed and we should have more employees in agriculture; however, they are not the same persons as have been doing the job previously. As reported[4] April 1, 13 per cent of the persons employed on farms were female. The actual number is indicated to be 1,233,000, an increase of 810 per cent from April 1, 1941. These women are tending to offset the decrease of 1,730,000 male employees during the same period. The agricultural engineer should recognize the farms of the country are a source of man-power for war and war industry. This is a contribution he has made possible through previous years of work. At the same time there may be an increase of actual numbers of persons in the agricultural labor force endeavoring to increase production. He should recognize that the quality of the employment is changed in character. The question naturally arises, can the numbers increase sufficiently from the farm population or other supplementary sources to increase production without also increasing the supplies of equipment to compensate for the change in quality of workers? The supply of farm equipment is inversely related to the number of persons employed. Stated another way, with each increment of labor reduction equipment added to the total amount on farms there is a reduction in the time required to produce the crops. (See Fig. 3).

TO IMPROVE LABOR EFFICIENCY IN FARM PRODUCTION MACHINERY IS ESSENTIAL

Only through machinery and relationship of machinery to labor are people working in agriculture able to produce more food than for their own requirements. For labor to improve its efficiency in agricultural production, it must have machinery geared with it. Any regression to less efficient machines, or in fact any less machinery, simply means that greater amounts of labor will be required. In the war effort, it is obviously impossible for agriculture to obtain additional help of a magnitude sufficient to compensate for the work capacity of persons leaving. Machinery for production is the primary means of reaching scheduled food goals.

The fact that we have this number of women now working in agriculture indicates that agriculture will bear the first repercussion of a wartime reduced standard of living. Agricultural engineers have contributed largely to higher living standards on farms and still greater contributions are necessary to maintain high levels of living standards.

Other sources of farm employees are the children, 2,500,000 on farms between the ages of 10 and 13 years. There are also some 10,000,000 others not in the labor

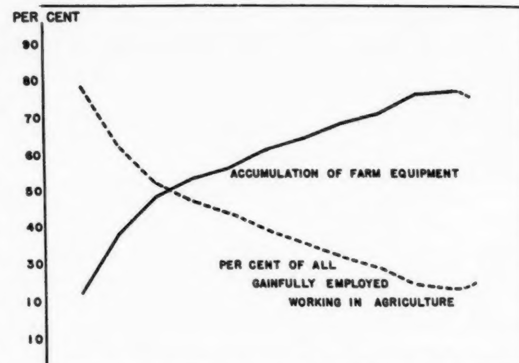


Fig. 3 Relation of equipment to time required to product food

force, mostly women, but including children to the age of 10[4]. So far as these marginal groups may be used as part of the agricultural labor force, while at the same time the supplies of labor-saving equipment are cut off, the basic relationship of Fig. 3 will have a tendency to change its course somewhat as indicated.

On the average each person in the labor force of agriculture will in 1942 feed at least 13 others. Many of our farmers are marginal farmers who barely produce enough food to feed themselves, thus the more enterprising must produce food for more than 13 others to make up for the marginal producers. Self-maintenance is important under any condition of our economy, but self-maintenance along with a contribution to the war effort to the maximum degree is the practice which we must honor most. It is the agricultural engineer who has made the indirect engineering contribution toward permitting the maximum of food production with the least expenditure of labor. As engineers we should see to it that this group of maximum producers is the least disturbed[5] in obtaining their supplies for production including necessary labor-saving equipment.

There is a tendency to maintain the marginal farmer[6] in this war foods effort. Many are frozen on subsistence tracts. It is doubtful wartime efficacy to maintain such individuals in their status. Perhaps with engineering we can assist those capable to consolidated tracts where they might maximize their production to average or better, while at the same time encouraging those less able to shift into war industry where directed control may produce the most for the war effort. This is the first opportunity for many years where consolidation of farms too small for maintenance of a single family could be adjusted with the least hardship. Such consolidation is desirable, of course, only in certain regions[7].

Farm equipment along engineered lines has made this high level production possible, with the least utilization of man power. Land use has apparently contributed little in the advancement of productivity as noted by Figs. 1 and 2. Labor itself must be geared with some equipment to increase its efficiency. Thus the marginal farmers must have equipment reorganization and new equipment to increase his productivity. Likewise labor on average and high level production farms must also maintain the substance of their equipment and indirectly the engineering involved.

Agricultural engineers should direct their efforts toward encouraging best practices which normally are slow of adoption. We should not use 300 man-hours to produce 100 bushels of corn if average U. S. practice[8] is 90 and the best corn belt experience is as low as 15. We should not be

consuming extra hours for grain, cotton, potato, vegetable, milk, chicken, and pork production when we can do these jobs faster some other way and by so doing make an even greater contribution to the war effort. Here is work for the agricultural engineer all along the line. We need the food, we need the manpower if it is not needed in agriculture, and we need some of the economic adjustments necessary for the well-being of farm population.

We have a national tendency toward boot strap lifting and to some degree this is being applied in our war foods effort. From an engineering point of view, it is doubtful economy as applied to our agriculture. Wartime experience of the majority of nations has led to greater degrees of mechanization of agriculture. Most nations of this war are increasing mechanization on farms. In Great Britain the war has had the effect of speeding some farming developments already in progress. Mechanical progress has been far more rapid since the war began[9]. At the beginning of the war, Great Britain had 52,450 tractors whereas at the end of 1941 there were 123,500, or more than 130 per cent increase[10].

There have been a number of references to the capacity of our farm plant equipment, indicating that we have little to worry about in reaching our food goals[11]. Others have indicated there were enough horses on farms to do all the work[12]. Agricultural engineers can aid the war effort by analysis of these statements or studies, if supported by study or facts, and determine the extent of hurried opinion or superficial consideration. As engineers, we cannot sidestep responsibility if we know conclusions are wrong or the responsibility of reaching wrong conclusions likely to lead to trouble in the form of food shortage.

Brief examination of some of the suggestions indicate fundamental weaknesses, or if not that then a gross lack of valid engineering in the design, selection, and use of farm equipment undetected through many years of established practice.

THE DESIGNER AIMS TO PRODUCE A MACHINE FOR A PARTICULAR AREA OR CONDITION

First referring to design, during the past few decades it has been the aim of the designer to produce a machine for a particular type of farm area, farm size, specific crop, and specific crop operation. The designer has incorporated sufficient capacity, including a safe factor of capacity to meet the conditions of use. Therefore, a majority of farm machines have a limited capacity toward the possibility of increased use, through joint use or custom operation, as has been proposed recently as the means of reaching the food goals. Pooling equipment among several farms may sound feasible, it may look well on paper, but does it stand engineering analysis? If the plan is good, we should know more about it, and if it is not a good plan, let us not be misled or mislead any farmers into disappointing results. On the surface, the suggestion, if applicable in general, stands as an indictment of the engineers to design correctly and of the farmers to select correctly. Long established practices are more inclined to be correct in the mass of instances than this suggestion indicates. There are, of course, specific instances on individual farms where surplus capacity is available from equipment, and for many farmers' joint use, borrowing, and custom operation has been the practice for many years.

We have a current inventory of approximately 6,100,000 farms with at least 4,800,000 bona fide farm operators[6]. Among these we have equipment to the extent of 1,800,000 tractors, 2,200,000 mowing machines, 2,200,000 hay rakes, 1,800,000 grain binders, 300,000 combines, 1,000,000 manure spreaders, and 300,000 milking machines[13]. On the basis of all farms in the country 70 per cent of them have none of these individual items of equipment. For example, less than one-half of one per cent of the farmers reporting the milking of cows have milking machines, and this is one of the many machines for which joint use, or other forms of doubling up on equipment, cannot work out in practice. Under 64 per cent of the farms reporting the production of hay could have a mowing machine or a hay rake according to this inventory; naturally, therefore, doubling up on such equipment is already an established practice. The question then to settle is — to what greater extent can joint use be practiced before the vanishing point of increasing capacity is reached?

FARM MACHINES HAVE BEEN PURCHASED TO FIT INTO SPECIFIC OPERATIONS

Secondly, farm sizes or the extent of farm operations have not changed except in a minor degree during the past two or three decades. Farm machines have been available in the majority of the cases in different sizes to fit the user's needs. Thus farm machines have been purchased to fit operations under consideration, and the majority of farmers have made intelligent selections of their machines. In view of this practice the contention[17] that farmers have a great deal more capacity in machines than is utilized is not a well-founded appraisal. It is only in the few minor exceptions where farmers have unwisely chosen machines where there is excess capacity available for doubling up on use and where additional capacity could be acquired under a wartime machinery shortage situation. Surveys on the duty of agricultural equipment are meaningless, however, unless distribution of the equipment over the area is such that the machines would be accessible to the farm operators in need of them.

Another suggestion of increasing machine capacity to offset shortage of supplies is custom operation. This is a generally practiced means of spreading work of a single machine or combination of machines over a number of farms resulting in the doubling up of machines. This is by no means a new practice, although many believe it so. It is as old as farm equipment itself, and only applies to certain items of farm equipment. Rubber tires on tractors and machinery have made the practice more flexible and universal within the past few years. Research has not been extensive on this phase of equipment management or use. There arise a number of questions in conjunction with the practice which should be answered in a practical manner and when answered may shed some light on the feasibility of increasing the activity: (1) Custom machines wear out faster from greater extent of use — will supplies be available to replace them? Farmers may be more reluctant now in wartime to engage in custom work in view of curtailed supply of machines because of their desire to conserve them for their own use. (2) With a 17 per cent reduction of male employees within the last year, will there be enough men available to operate the machines? (3) With a further reduction of male employees and the extended work activities on every farm, will time available permit farmers to go out and do custom work? (4) Can crew sizes be maintained, in the midst of a labor shortage, sufficient to keep from disorganizing the work? (5) Is custom work an encouraging business enterprise, except during depression times? With high wages in industry, it would appear that few operators would be encouraged to enter this field of business. (6) With the rubber situation as acute as it is and elimination of tires from equipment, will there not be a tendency to discontinue the practice?

Thus it would appear that custom operation has its limitations, and the factors of decreasing the activity are stronger than those tending to increase the practice.

It is estimated that on our farms there are 1,800,000 tractors, 1,047,000 trucks, and 4,144,000 automobiles, and that the power plant is in the aggregate the largest on record[11]. For primary production of food and feed crops, however, tractors and animal power units are the only units of substantial value. Trucks and automobiles are indispensible in conjunction with farming, but contribute little if anything to crop production. Tractors in this count include everything on wheels including improvised homebuilt units of limited value in food and feed crop production, garden tractors, and old tractors used as stationary power units principally. While many tractors are new, the average age, according to the 1940 census, is seven years; therefore, many very old tractors must have been included in the counts.

During the past decade of census figures, there was a decrease of 4,085,000 animal power units and an increase of 637,000 tractors on farms[15]. This is a ratio of change of 1 tractor replacing 7.5 horses. Animal power population does not maintain itself by a net annual unit replacement of 434,716 necessary to maintain itself static, according to the 1940 census.

A TOTAL OF 57,962 TRACTORS REQUIRED TO REPLACE DECREASING WORK ANIMALS

Based on the record of the past ten years, there are annually required 57,962 tractors to replace the declining trend of animal power unit population. It is probable that this ratio is currently more nearly 1 tractor to approximately 4 animal power units. In this case, there would be needed about 109,000 tractors to replace estimated birth rate under death rate of animal power units. Further, because of withdrawals of animal units from farms to city use, a new trend, this number of tractors may be considerably too low for animal replacements. It is estimated[16] that approximately 85,000 tractors are needed annually to replace worn-out units. Thus it is indicated through past experience that approximately 195,000 tractors are required for replacements only. It has been a contention that four steel-wheeled tractors are needed to equal the work capacity of three rubber-tired tractors, and now that rubber tires are not available for new tractors there exists an additional circumstance of tractor replacement requirements to maintain the substance of our farm power plant.

Thus tractor production rate for which materials were available in 1942 falls short of a maintenance level. While it is advocated that life of tractors may be prolonged by repair, many of these 85,000 required units are obsolete to the degree that repair in the face of farm labor shortage is not good engineering, and is also questionable in conjunction with increasing food goals for the war effort.

The downward trend in animal power population is not reversible except in obedience with biological laws, a trifle slow for our needed requirements in the next few years. Critical analysis of animal ages and breeding returns gives indication that the trend cannot be reversed within a period of a number of years.

Another point due for consideration in our war effort is the fact that the character of our food needs is being changed. We are emphasizing the increase of consumption of secondary agricultural products, namely, livestock products instead of direct consumption of primary foods like grain. Grain and corn production are accomplished by the highest degrees of mechanization used in our agriculture. We are adding greater amounts of manual labor in the process therefore than if we were to consume grain products directly. We also lose efficiency in the conversion of the primary crops into human energy. Not only should the agricultural engineers consider this but also the governmental planning agencies to insure the ability of the farm plant capacity to maintain food resources for the war effort. With the shrinking work capacity of the farm labor force the engineer may now need to give more attention to livestock product producing equipment and the means of obtaining higher qualities of feed for livestock. This change in types of food tends to multiply the labor requirements to a considerable degree.

The social elevation of farm people, the changing food habits, the increasing labor requirements for new types of food and oil seed crops, the need for equipment reorganization to produce new foods and maintain land conservation, the maintenance of our farm power plant, the increase of food production, the shortage of materials to produce equipment, and the decrease of work capacity of the farm labor force are all being considered as a part of the war effort. The burden of solution of these matters does not all fall on the shoulders of the economist. The engineer has a full responsibility, for if he is an engineer, he is also an economist and just as able to surmount economic and social problems as any other class of scientist.

In combat, transportation, and tools of war, this has been referred to as an engineer's war. It appears to me to be no less so in food production for war.

If agricultural engineers have any solution to this dilemma, any effectual answers to these problems or any workable measures to substitute for materials no longer available for tractor and tractor equipment and other equipment production, such ideas are of immeasurable importance to the war effort.

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Methods of Moisture Drainage from Silos

By C. K. Otis
MEMBER A.S.A.E.

ENSILING the hay crop has become an established farm practice, especially in regions where it is difficult to put up hay by natural curing. This method of preserving forage crops is spreading, and machinery has been developed to cut and chop the hay in the field making production a highly mechanized process.

There is a great deal of discussion pro and con over the merits of this process, but in the meantime many farmers are putting up their hay crop in this manner.

Some difficulties are encountered, however, in this modern method of making hay. The crop is put into the silo at a rather high moisture content and seepage of juice occurs frequently at construction joints in the walls. This juice is corrosive to both steel and concrete and, on exposure to air, develops a highly disagreeable odor. Since the ensiling of high moisture crops seems likely to continue, some means of preventing seepage in the silos used for that purpose is imperative.

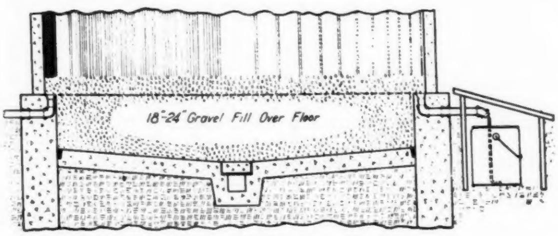


Fig. 1 A diagram showing the drainage system employed in the experimental silo

The division of agricultural engineering of the University of Minnesota in cooperation with one of the large stave silo manufacturers has started a project to study methods of dealing with this problem. It was started just a year ago and one season's work has been completed. The primary objectives of the project are to determine (1) the amount and the rate of flow of juice to be expected under various conditions, (2) how the juice finds its way out of the silo from the silage mass, (3) the chemical composition of the juice drained off, and (4) development of a method of construction that will insure a minimum of leakage.

Paper presented June 29, 1942, at the 35th annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis. A contribution of the Farm Structures Division. (Paper No. 2017, Scientific Journal Series, Minnesota Agricultural Experiment Station.) Author: Assistant professor of agricultural engineering, University of Minnesota.

A 14x45-ft silo was constructed especially for the project and equipped for obtaining data that would help gain the required information. The location chosen was a farm on which were already five silos, two of which were used for alfalfa silage. One of these, a 14-45-ft silo, was used as a check against the experimental silo and was equipped with a gravel bottom and a side wall drain to a height of 20 ft on each side of the doors. The location of the experimental silo is excellent for this study since the juice can be carried by gravity into a small pond nearby.

Essential features of the experimental silo are as follows: Fig. 1 shows a diagram of the drainage system employed. The wall was divided into four quadrants two of which were plain walls similar to a conventional concrete stave silo. One-half of the wall including the doors was thus the same as a standard silo. The other two quadrants were equipped with sidewall drains. The wall drainage was collected from each quadrant separately by means of a trough cast in the top of the foundation wall that carried the juice to an outlet pipe, and thus to a pail outside where the liquid was measured. The concrete floor was equipped with a drain trough running across the diameter of the silo. The trough was covered with concrete plates that were fitted loosely to provide easy passage for the juice. The entire floor was covered with a layer of gravel. Fig. 2 shows the two types of sidewall drains employed. The drains at the left consisted of continuous grooves cast into the staves. These grooves are 1/4 in deep and 1/4 in wide, about 1 in apart, and extend to the top of the silo. The drains used on the wall at the right consist of perforated metal ducts inserted into grooves cast into the staves. These ducts were placed 10 in apart and extend up 25 ft. The purpose of extending one set of drains to the top was to see if there was any possibility of air lock developing in the sidewall drains.

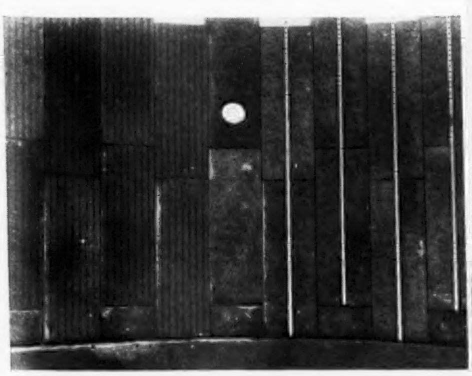
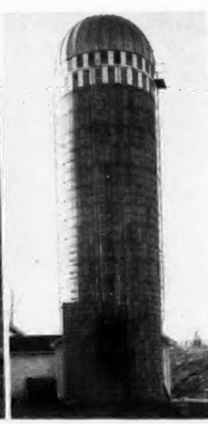




Fig. 2 (Left) Inside wall of the experimental silo before plastering, showing the two types of sidewall drains and one of the density portholes • Fig. 3 (Center) Exterior of the completed silo showing the density portholes, the location of manholes, and the sampling equipment mounted on the wall • Fig. 4 (Right) Removing a sample of silage by means of a large corkscrew. The sample is carefully collected and weighed and the depth of the hole measured to determine the density of the silage

The large hole at the center of Fig. 2 is one of the portholes provided at 5-ft intervals up the side of the silo for extracting density samples. It was felt that a more definite knowledge of silage densities was needed than was available at the time this silo was designed. It was then decided to attempt horizontal sampling to determine density of the silage in place. There are two reasons why such a course seemed advisable. One was that the variation in silage density from the wall to the center of the silo could be determined, and the other was that there would be no doubt as to whether or not the density of the silage in the lower layers would be affected as the material above was removed.

Fig. 3 shows the exterior of the completed silo. Covers to three of the manholes provided for juice collection can be seen. The floor drain manhole is directly in front, and two of the four sidewall manholes are seen on either side of the center. There are three ladders for easy access to portholes provided in the walls. The large density portholes are $4\frac{1}{2}$ in in diameter and are placed at 5-ft intervals on one side of the silo. Portholes at 5-ft intervals are also provided for temperature readings and inspection purposes on two opposite sides of the silo near each of the ladders seen in profile. The apparatus shown suspended by ropes on the side of the silo is used for taking density samples through the portholes.

The density sampling device shown in Fig. 4 consists of a frame supporting two guide bars on which slides a crosshead. The crosshead is drawn toward the silo by cables actuated by a hand-operated winch. A 4-in seamless steel tube is provided with cutting edges at one end and a turning head and thrust bearing at the other. The crosshead applies the pressure to the turning head through the thrust bearing and forces the tube into the silage. Bars mounted in the turning head are used for oscillating the tube to cut the sample free as the tube progresses. A platform for the operators is suspended by ropes from the top of the silo. In taking a sample, two men operate the turning head cutting the sample free as the third man forces the tube into the silage by means of the winch. Fig. 4 shows the tube half way into the silage. A portion of the sample is being extracted by means of a large corkscrew. The sample is carefully weighed and the length of the sample measured to make it possible to determine the density.

The results obtained from the drainage studies can best be shown graphically. Fig. 5 shows the drainage rate for the first eight days from the experimental silo and from the check silo. The peak rate of 8 gph (gallons per hour) from the check silo occurred before filling was completed and rapidly diminished to about 1 gph on the eighth day after starting to fill. The experimental silo reached its peak of 11.8 gph just after filling was completed and maintained a high rate of flow for somewhat longer than the check silo. On the eighth day after starting to fill, it was still draining a little more than 2 gph. A weighted average moisture content could not be obtained for the check silo because the weighing equipment was not installed in time, but the average of 20 samples was 70 per cent against a weighted average of 72.3 for the experimental silo.

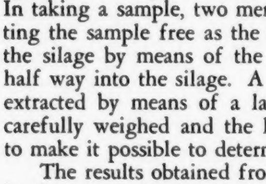
Fig. 6 shows the comparative rates of drainage from the floor, the grooved half of the silo, and the plain half for the first eight days after starting to fill. The peak drainage rate of the floor drain is about double the peak of the grooved half, and the grooved half peak drainage is about double that of the plain half. Included in the plain half drainage is that from two metal duct drains on either side of the doors extending up 30 ft from the bottom. How much juice flowed down these drains is not known, but it might be enough to influence the quantity from the plain half of the silo.

TABLE 1. SUMMARY OF DRAINAGE DATA FOR EXPERIMENTAL AND CHECK SILOS (Project 136 — 1941-42)

Location	Cumulative drainage 1st 10 days, gal	Final Gal	Final Lb*	10-day drainage, per cent of final	Per cent total drainage at 10 days	Per cent total drainage at Final
Experimental Silo						
N.W. (plain wall)	59	130.5	1,148.0	45.2	7.1	7.2
S.W. (plain wall)	55	123.5	1,087.0	44.5	6.6	6.8
N.E. (grooved stave)	120	186.5	1,639.0	64.3	14.3	10.3
S.E. (metal ducts)	108	173.5	1,523.5	62.2	12.9	9.6
Wall (plain half)	114	254.0	2,235.0	44.9	13.6	14.1
Wall (grooved half)	228	360.0	3,162.5	63.3	27.3	20.0
Wall (total)	342	614.0	5,397.5	55.8	40.9	34.1
Floor	463	1160.5	10,201.5	40.1	55.3	64.1
All drains	805	1774.5	15,599.0	45.5	96.2	98.2
Leakage	31.5	33.0	289.0	95.5	3.8	1.8
Grand total	836.5	1807.5	15,888.0	46.4	100.0	100.0
Check Silo	446	1378.0	11,979.0	32.4		

*Density of juice: Experimental, 8.79 lb per gal; Check, 8.69 lb per gal

A summary of the drainage data presented in Table 1 shows the cumulative drainage in gallons for the first ten days and in both gallons and pounds for the final quantities collected from the various parts of the silo. The ten-day drainage from each part is also expressed as a percentage of the final amount collected from that part. The drainage from the separate parts is also expressed in percentage of the total drainage from the silo at the end of the first ten days and at the end of the season. Juice was still trickling out when only a foot of silage remained in the silo, and the last measurement was recorded 307 days after starting to fill. Two-thirds of the final drainage came from the floor and one-third from the walls. Twenty per cent of all drainage came from the grooved half of the wall and 14 per cent came from the plain half. Forty-six per cent of the final drainage from all sources ran off the first ten days which seems to be the critical period as far as seepage is concerned. Sixty-three per cent of the final drainage from the grooved walls came off the first ten days, while 45 per cent



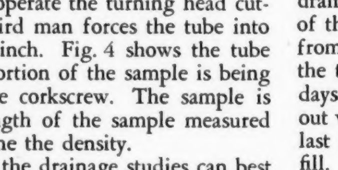


Fig. 5 (Left) Comparative rates of drainage from the experimental silo and the silo used as a check • Fig. 6 (Right) Comparative rates of drainage from the component parts of the experimental silo

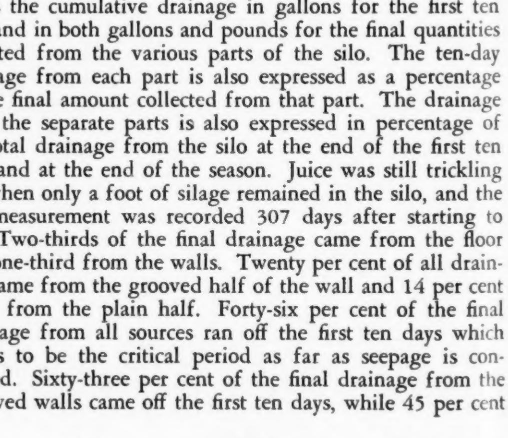


Fig. 7 Weight balance and summary of juice analysis for the experimental silo for the 1941-42 season

of the final from the plain walls and 40 per cent of the final from the floor ran off during the same period.

Fig. 7 shows the weight balance of the experimental silo. The total weight of all material placed in the silo was 122 tons with an average moisture content of 72.3 per cent. Of this original material approximately 88.7 per cent was removed from the silo as edible silage, 4.4 per cent was inedible due to spoilage, 6.5 per cent was removed in the form of juice, and 0.4 per cent was unaccounted for which probably represents the gases escaping to the atmosphere and evaporation losses.

The drainage was composed of 93.4 per cent water, 3.2 per cent crude protein, 2.0 per cent mineral ash, and 1.4 per cent other solids mostly nitrogen-free extract. Of the 2,112 lb of phosphoric acid placed in the silo, 90 per cent was retained in the silo and 10 per cent was lost in the drainage. A complete summary of the juice analysis is given in Table 2. The estimated loss of nutrients in the juice for the silo as a whole is recorded in Table 3. The indicated percentage of mineral ash lost is probably quite high since some of it may have been picked up from the walls, gravel, and floor of the silo.

TABLE 2. SUMMARY OF JUICE ANALYSIS FOR EXPERIMENTAL AND CHECK SILOS (Project 136 — 1941)

Item	Total drainage	Total solids	Mineral ash	Crude protein*	Other solids	Water	H_3PO_4 (Conc.)
Side walls,							
total lb	5,397.5	358.9	135.0	174.7	49.2	5,038.6	79.1
% of total	100.0	6.6	2.5	3.2	0.9	93.4	1.5
Floor†,							
total lb	10,490.5	687.4	188.7	331.3	167.4	9,803.1	80.3
% of total	100.0	6.6	1.8	3.2	1.6	93.4	0.8
All drains,							
total lb	15,888.0	1046.3	323.7	506.0	216.6	14,841.7	159.4
% of total	100.0	6.6	2.0	3.2	1.4	93.4	1.0
Check Silo							
total lb	11,979.0	894.0	211.5	412.5	270.0	11,085.0	57.5
% of total	100.0	7.5	1.8	3.4	2.3	92.5	0.5

*Probably all digestible protein †Includes leakage from doors

It is interesting to note that the change in moisture content of the ensiled material represents a moisture loss of 21.4 per cent of juice drained from the silo. Six and six-tenths per cent was composed of solids leaving 72.0 per cent of the total as water that must have been produced by the fermentation process. Loss in dry matter was 4,643 lb.

Fig. 8 shows the variation of silage density in the settled material. The density diagram was plotted from data obtained from core samples. Since the samples cut only to the center of the silo, the other half of the diagram was made symmetrical except at the bottom where a sample was obtained from both sides, making it possible to obtain the variation in density across the full diameter.

TABLE 3. ESTIMATED LOSS OF NUTRIENTS IN JUICE FROM EXPERIMENTAL SILO

Item	Dry matter, or total solids	Mineral ash†	Digestible protein*†	Other solids	Water	H_3PO_4 75 % com.
Placed in silo, lb	65,752	5,871	7,750	52,131	176,113	2,112
Removed in juice, lb	1,046	324	506	217	14,842	212.5
Removed in juice, %	1.6	5.5	6.5	0.4	8.4	10.0

*All protein in juice considered digestible
†Based on green alfalfa in bloom

Values taken from "Feeds and Feeding", by F. B. Morrison

The black area represents the heaviest silage which had a density of 60 lb or more per cubic foot. The layers that surround this heaviest material decreased in density until in the vicinity of porthole 4 the density increased somewhat and then decreased again until the surface of the silage was reached. The diagram was not based on sample data in that portion near portholes 6 and 7 since the sampling equipment was not completed in time to reach the last two portholes before they were exposed.

Densities were obtained in two different ways. First by the core sampling method with the silage in place, and then by the volume weight method as the silage was removed. The two density curves are plotted together and very close agreement between them was obtained.

It seems reasonable to expect that the path of the juice would be the path of least resistance. Since the material in the silo is fibrous, the paths can be likened to small tubes and passages through the mass. The denser the mass, the smaller would be the passages, and consequently the greater would be the fluid friction.

The variation of density within the silo indicated by Fig. 8 seems to point to the feasibility of sidewall drainage. Vertical passage of juice is more difficult since the juice meets increased resistance as it moves downward thus slowing its progress. To overcome this resistance, it must build up additional head by allowing juice to accumulate. If there should be a slight crack in the wall at a point where this head is increasing, a leak is likely to appear since the pressure of the liquid is greater than atmospheric.

It can be seen from Fig. 8 that in most of the lower part of the silo the density decreases laterally from the center to the outside wall. Thus the juice should be able to flow laterally quite readily since it would meet with less resistance. If means are provided for conveying this liquid away at atmospheric pressure as soon as it reaches the inside wall surface, it appears logical to expect reduced danger of leakage through small fissures in the wall. Thus it would seem that the principle of sidewall drainage is sound.

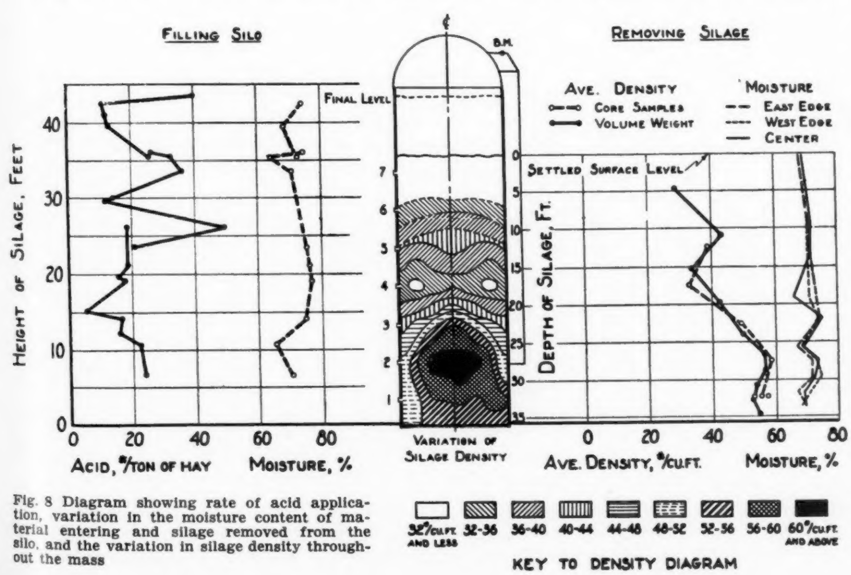


Fig. 8 Diagram showing rate of acid application, variation in the moisture content of material entering and silage removed from the silo, and the variation in silage density throughout the mass

The Production of Guayule Rubber Under Irrigation

(Continued from page 312)

replace the more costly irrigation water. Just when the Salinas project was getting well established, with 8000 acres in various stages of growth, it was seriously set back by the depression. Many fields of mature guayule were burned. But the growing of the guayule shrub as a cultivated crop was kept alive, and some minor markets were found for uses in which guayule rubber is superior to hevea rubber and therefore commands a higher price. About 200 tons were produced last year. By plant selection the rubber content of the dried shrub has been raised from the 13 to 17 per cent extraction of the wild shrub in Mexico to well over 20 per cent, even 22 and 23 per cent for individual strains.

Important advances at Salinas have been made in mechanization. One has been the designing and building of harvesters which gouge deep so as to secure the roots as well as the tops, like an oversize potato harvester. The material is windrowed, and then picked up by an implement which chops the stems and roots into pieces not over 2½ in long and discharges into trucks for hauling to storage bins or the mill. Another advance over the practice near Tucson is the nursery planter. It spreads the chemically treated, pregerminated seed evenly over the prepared seedbed, covers it with a thin layer of fine sand, and lightly rolls it. The seed is gathered by drawing over the plants an implement with canvas hoods, open at the bottom, with a strong upward suction of air. Six-row field planters have been built. So far these implements have been built as needed on or near the ranch.

The guayule shrub has been quite free from plant diseases and pests. However, difficulties of that sort may appear in the future. It is believed that the shrub would not have great tolerance for alkali, but no very definite statement on that point can be made.

Great credit is due the president of the Company, George H. Carnahan, an engineer, who in 30 years never lost faith, who saw the desirability of a supply of rubber within continental America, and who made efforts to win industrial and political leaders to his views. He died as the direct result of his strenuous efforts to keep the guayule industry functioning. With a hostile board of directors and a ledger in the red, he persevered doggedly in the firm belief that the domesticated guayule rubber would be needed. One possibility which he visualized was the introduction of the leaf-spot disease in the Far East.

THE CHEMICAL NAME FOR TRUE RUBBER IS "POLY-ISOPRENE"

The competitive price of Far Eastern rubber now is not a consideration. Higher costs must be faced. Synthetic substitutes for rubber are to be manufactured in great volume. The substitutes should not be called rubber. (The chemical name for true rubber is "poly-isoprene"; the substitutes should be given names appropriate to their composition or to their physical properties.) Certain of these substitutes, such as Buna S, make excellent tire treads; they have not proved entirely satisfactory for carcasses when used alone without natural rubber, that is, not so good as natural rubber. It is hoped that the penetrating and adhesive properties can be improved so that good tire carcasses as well as the treads can be made wholly of the synthetic substitutes. It may not be possible; the Germans did not succeed in building satisfactory carcasses with less than 35 per cent natural true rubber.

Therefore, it is highly important that efforts to grow guayule rubber be pushed to the limit, the limiting factor being the seed supply. So far as can be fôreseen, the cost of deresinated guayule rubber will be considerably lower than that of synthetic substitutes, depending partly on how completely the production is mechanized.

From two to three million acres should be planted to guayule. The areas available for guayule in the coastal valleys of California with bountiful fog are not extensive. Most of this acreage must be on irrigated land, regardless of cost.

The federal government took over the guayule project at Salinas on March 5. The government did not buy a gamble. The commercial production of guayule was amply demonstrated in the five years at Continental near Tucson under irrigation and subsequently at Salinas. There is no more reason to doubt the feasibility of guayule as an agricultural crop than that of beans or peanuts.

The whole stock of seed accumulated by the Intercontinental Rubber Company—22,000 lb—has been planted at Salinas on 750 acres under an overhead sprinkling system. I believe the planting should have been divided, with nurseries at several places within easy reach of areas to which the seedlings will be transplanted. The responsibility for multiplying the seed and for the general development of the industry has been placed on the U. S. Forest Service, one of the most efficient of our governmental agencies. A small part of the 1942 nursery seedlings at Salinas has been planted this spring in a hundred test plots, about thirty of them in Arizona, to test soils and climates. This test work is in the hands of the U. S. Bureau of Plant Industry. About 7,000 seedlings have been set in each test plot, approximately an acre.

The inevitable question is, why did not the private company succeed? Erroneous statements have been made. The answer is: if great importations of wheat at 25 cents a bushel should be made, how much wheat would be grown commercially in this country? None!

THE COUNTRY MAY NEED GUAYULE RUBBER IN CASE THE WAR IS A LONG ONE

The guayule plantation at Continental attracted little attention at the time and was soon forgotten. It served an important purpose, however, as a test and demonstration of guayule production under irrigation. Except financially, it was entirely successful. The records of that planting and those at Salinas justify the present projected development on a scale commensurate with the country's needs. Highly placed authorities predict a long war. We may need the guayule rubber more in 1946 and 1947 than in 1943 and 1944, if we want our mechanized armies to travel at as high speeds as do the tanks and supply trucks of our enemies.

I should like to refer to the proposals to obtain rubber from goldenrod, dandelions, poinsettias, milkweeds, rabbit brush and other plants with ½ to 5 per cent rubber, the percentage to be increased by breeding and plant selection. In the national emergency that does not make sense, when we have already the hardy guayule with 20 per cent rubber which has been under cultivation 30 years, during which time the detailed best methods of raising the crop, of extracting the rubber from the plants, and of fabricating it into tires have all been worked out. Rubber from milkweeds is in the experimental stage.

Just one more addendum. After the war the whole world will be crying for rubber, and prices will permit continuation of guayule production for many years.

Changes in Hay Handling Methods and Equipment

By A. E. W. Johnson

MEMBER A.S.A.E.

THE hay crop, being one of the four major crops in the United States, has required various methods and types of harvesting equipment. The character of the land devoted to the crop and the wide deviation in acreage per farm are responsible for vast differences in labor requirements. The usual methods of harvesting are at times confronted with adverse weather conditions and, with the exception of the larger growers, too much labor is still necessary at haying time.

The scarcity of farm labor and equipment during the last World War made the providing of food for ourselves and our allies a paramount issue. Our farmers today have a still greater responsibility. However, they will accomplish this job with less help, and with but a portion of their annual requirement of tractors and farm equipment. The significant fact is that our present mechanized agricultural equipment is sufficient so that we can divert a substantial portion of man power to our armed forces and to the production of military requirements. Likewise, tractor and farm machinery factories have been converted largely for that all important job ahead. This is indicative of the advancement in agricultural methods and equipment.

Acceptance of the mechanization of agricultural methods began soon after the first World War. Previously, tractors were used for plowing and belt work. They were available only for those who could afford and justify this equipment for these limited operations. The introduction of the general-purpose type of tractor brought forth a new era of farming. Methods of harvesting hay, likewise, were modified to utilize the power of the tractor for mowing, raking, baling, and subsequent storing operations. The use of tractors, trucks, and automobiles in a relatively short span of time released millions of acres of land for more productive purposes. Formerly this vast acreage was required for feeding horses and mules used in farm work and in the transportation of goods.

Tractor mowers gained in popularity rapidly, as three to four times the acreage could be cut in a given time compared with the conventional horse-drawn mower. Therefore, the farmer, at a considerable saving in cost per acre, had more time to care for other crops requiring attention during the haying season. He could also cut a larger acreage at just the right time and thus obtain a better quality of hay.

Raking and loading the hay crop is always a slow laborious job. The quality of hay is severely impaired by delays, and while side-delivery rakes were developed some time previous to the more general use of the tractor, advantages of these machines were not fully appreciated until later. After a time the side-delivery rake was further improved by the four bar design having quick attachable and removable teeth, enclosed gears, and also made more durable for tractor use. The use of the side-delivery rake provided a better quality of hay, and prepared it for loading. Hay loaders also gained in favor by reducing operating costs and the manual labor of loading by hand.

During this period, sweep rakes were adapted to the tractor, and in grassland areas where vast acreages permitted their use, large quantities of hay could be handled at extremely low costs, as compared with the usual methods in diversified crop territories. In these areas, high-speed trailing mowers were coupled to tractors upon which direct-connected mowers were mounted. With this arrangement of equipment, one man can cut a 14-ft swath, or 20 to 30 acres per day.

Hay stackers continued to be prevalent in the grassland areas where stacking was of necessity the lowest in cost and the most practical method of storing hay.

A great deal of development work preceded our recent efforts to improve the efficiency and broaden the scope of baling presses. Before the first World War, storage and shipping hay was exceedingly important, as millions of tons were used annually in urban areas. As the demand for hay in these areas decreased, the requirement for hay presses reached their limit in sales volume. Because of this situation, new development was retarded until later when the shortage of labor on the farm made it necessary to devise more efficient and economical hay machinery.

The heavy stationary engines mounted on hay presses were replaced by lighter and more efficient gasoline engines similar to those used in automobiles and trucks. The general use of smaller tractors introduced a new power for driving presses, thus making these machines decidedly more convenient and less expensive. The demand for horse presses decreased, and light power presses for individual use came forward, except for large baling operations. The need for more efficient, economical baling, the introduction of the light stationary press, and the pick-up baler, accelerated hay press sales.

In California, and possibly other sections of the country, the hay press was used in conjunction with a loader for harvesting from the windrow. The advantage of this method, besides lowering the labor costs, was that a reduction in the number of individual operations reduced the scattering of leaves, and consequently an improved quality of hay was obtained. At first this method was considered doubtful for most territories, but gradually, as in the case of the grain combine, tests encouraged others to investigate and finally try this new system of harvesting.

Usual practice required the *(Continued on page 327)*

Paper presented June 29, 1942, at the 35th annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis. A contribution of the Power and Machinery Division. Author: Manager, implement engineering, International Harvester Co.

Remodeled Barns Help Meet Wartime Needs

By John M. Anderson

JUNIOR MEMBER A.S.A.E.

DEMANDS for vast quantities of material and labor have forced the War Production Board to curb all non-essential construction. To stop speculative and unnecessary building, the WPB issued a series of limitation orders regulating all types of construction. It has been their policy, in all rulings, to prevent the replacement of any building where it was possible to remodel or rebuild it to a functional condition. Therefore, to enable the American farmer to provide adequate shelter for an increased number of livestock and to still build within the present restrictions, there is a definite wartime need for some method of economically and permanently reconditioning farm buildings. An excellent solution to this problem has already been developed by a number of Middle West farmers, which could readily be adopted in other sections of the country.

In this area there are many of the once famous old red barns depreciating to a near state of ruin. Deterioration is most evident on the walls near the grade line where rain and ground moisture have rotted off the ends of the siding and large pieces of the boards have been entirely broken away. Not only are the animals thus exposed to wind and rain, but insects, parasites, and germs take refuge in the decayed wood, contributing still further to unhealthful conditions.

Too often these old barns have inadequately or improperly designed footings which have not been extended deep enough below the grade to prevent heaving from frost action, or which have not been given ample spread to prevent settling, thus causing the building above to lean, sag, or bulge.

Most of these old barns are structurally sound above the mow floor which indicates that by rebuilding the foundation and walls up to the mow floor, the barn can be returned to a functional condition and continue to render good service for years to come. Replacing only the deteriorated lower walls of the building with hollow tile fits naturally into the remodeling scheme, and future upkeep costs on this type of wall are extremely low. With a relatively small financial outlay, the present value of the old barn can be greatly increased through rebuilding, and its future service value assured.

The most common rebuilding procedure is to jack up one-half of the barn at a time; cut off the lower frame wall; pour new footings and foundation walls; build up a new wall of tile to the required height; lower the upper portion onto the new wall, and anchor it securely thereto. Then repeat this process on the other side of the barn.

The old barn is lifted by placing temporary timbers (6x8 in) up against the mow floor joists about 2 ft in from the outside wall. These timbers are held in place by means of 6-in posts spaced about 6 ft on center and supported by jack-screws. By operating the screws, one-half of the building can be easily raised 5 or 6 in, or to a height giving sufficient clearance for a mason to complete the new wall.

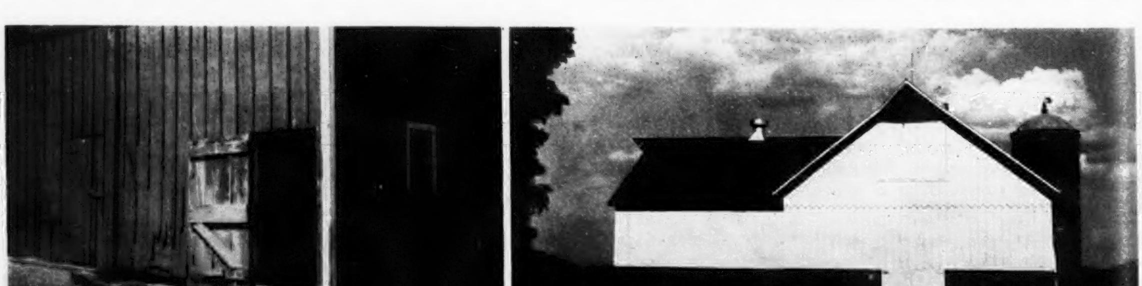
After the barn has been raised, that portion which is to be replaced with tile is removed. The old siding is cut off 3 in below the bottom of the mow floor joists to allow a lap over the new plate on the tile wall. The studs and vertical timbers are cut off flush with the bottom of the joists.

In most remodeling jobs it is necessary to replace the old footings with new ones. On jobs of this kind, the most economical foundation wall and footing is usually of poured concrete. A narrow trench should be dug to a depth below the common frost line in that locality. Both sides of the trench should be cut back to increase the width at the bottom of the footing and give adequate bearing area. It is recommended that 2⅝-in diameter reinforcing bars be placed in the bottom of the footing so it will act as a reinforced concrete beam in case the soil beneath should settle. The top of the foundation should stop at the grade line, or at floor slab level if slab and foundation are constructed together, and should be finished off square and level to give a firm bed for the tile wall above.

After the foundation wall has set sufficiently, the tile may be laid. A divided mortar bed type tile is preferred to a flat bed type for it helps prevent the entrance of moisture from the exterior. Tile having double exterior shells enable the mason to get full, tight head joints which also lessens any possibility of moisture penetration.

As the wall is built up, new door and window frames are set in position. Quite often it is possible to salvage the

Paper presented June 29, 1942, at the 35th annual meeting of the American Society of Agricultural Engineers at Milwaukee, Wis. A contribution of the Farm Structures Division. Author: Field engineer, Structural Clay Products Institute.



(Left) Before remodeling was started • (Right) The same barn after completion of remodeling

old sash and fit them into new frames, but if their salvage value is questionable new window sash should be installed. When a unit masonry sill is used under windows, flashing should be installed under the sill. This will prevent moisture from seeping through the sill and entering the wall. It is also recommended that caulking be carefully applied around the edges of all door and window frames as a precaution against moisture penetration and decay of the wood frame.

When the wall is brought to the required height, a 2x8-in wood plate is anchored to the top with ⅝-in anchor bolts spaced 6 ft 0 in on center. These anchor bolts are set by the mason as he builds the wall and should be anchored into the wall at least three courses below the plate.

After the new tile wall is finished and the new plate bolted firmly to it, the upper section of the barn is lowered onto the plate and securely anchored by toenailing the mow floor joists to the top of the plate and nailing the siding into the side of it. The other half of the barn is then rebuilt in the same manner.

To complete the rebuilding job it is often necessary to straighten out and line up the upper section, adding braces where necessary. After the structural remodeling is completed, the doors, windows, trim, and siding on the upper portion should be painted and the roof repaired.

It is impossible to give accurate estimates on the cost of remodeling any given barn without a careful inspection of the structure itself. The cost will be determined largely by the condition of the building and the extent to which it must be remodeled, as well as local labor and material costs. It should be pointed out, however, that many farmers have remodeled their old frame barns, following the same procedure that has just been described, for as little as one-third the cost of an entirely new structure of the same size.

For all practical purposes a barn thus remodeled is as functional and convenient as a new one. It is the patriotic duty of every agricultural engineer to encourage construction of this nature to conserve materials and labor for our national war effort.

Changes in Hay Handling Methods and Equipment

(Continued from page 325)

use of a mower, dump or side-rake, and hay loader, in addition to a wagon and rack for hauling to the barn or stack. This required several men and a considerable amount of hard work. If the hay was then to be baled, additional labor was needed for baling, and to dispose of the hay after baling was completed. The use of pick-up balers reduced the number of men required and lowered costs. These machines, in many conditions, required only a mower with swathing attachment for cutting and windrowing. Three men were required on the baler as operators, and one man to drive the tractor. Two men, with a wagon and rack or a motor truck, delivered hay for storage or direct to dealer.

Later improvements further reduced the number of men required to operate pick-up presses. The practicability of this method, along with new features and designs, established this method of harvesting where operations justified the expenditure involved.

While the pick-up press reduced labor materially, weather hazards are still present, as in the older methods of handling hay.

Numerous attempts have been made to overcome these obstacles. Artificial dehydration of forage crops is one method which not only avoids field losses, but eliminates to a large degree the weather hazard. Hay is more nutritious when this practice is followed as there is no loss of mineral elements, and the carotene content is higher than in field-cured hay.

While this method of curing hay has not been accepted for general farm use, nevertheless a considerable quantity of forage is now dried artificially. Use of hay dryers has been confined commercially to feed processors, large farming organizations, and a few producers. Interesting data is available on smaller installations designed for individual or more general farm use. It does not seem, however, that the trade generally will accept this system of curing hay until the initial cost of this type of installation and operation is sufficiently low to be attractive to the smaller growers.

Concurrent with the development of improved machinery for handling hay, a great deal has been learned of its nutritional value in the various stages of handling. For years previous to this country's acceptance of the grass silage method, some European countries preserved their grass crop in its natural state in trench or pit silos.

The production of silage, made from various grasses, is probably the latest development in the harvesting of the hay crop, and is not dependent on favorable weather. When grass silage was first introduced in this country, much equipment was necessary—the mower, rake, loader, wagon and rack, also a silo filler, all of which required a considerable amount of labor.

The field hay chopper, which picked up dry hay from the windrow, chopping it into short lengths for convenience in storing, was probably the forerunner of the green hay chopper or forage harvester. This machine is a combination mower, hay chopper, and loader. For operating, only one man is required on the tractor and a man for loading. The reduction in operating expense over previous methods is extremely attractive. For this reason, this method will, without doubt, become established generally for harvesting hay and grass when such crops are desired for silage. Storing the crop in the silo requires the use of a blower or an ensilage cutter equipped with molasses pump for adding molasses or acid preservatives. With this method, the food value of the hay crop is maintained to its highest degree, and much time and expense are saved in harvesting the standing crop or processing it to its finished product.

In reviewing the many diverse methods of hay harvesting, attention is called to requirements and economic conditions which determine to a great extent the methods used in various sections of the country. The type of land devoted to this crop, and the wide variation in acreage, without doubt, has had a definite effect in shaping the type of equipment used. The introduction of new pasture grasses, some of which will be cut for hay, may bring on new harvesting problems. Unquestionably there will continue to be various methods and equipment used in the handling of our domestic hay crop.

Of the new hay harvesting machines, the recent development of the forage harvester seems to offer considerable promise.

Although some hay will be necessary when grass silage is fed, the forage harvester can be used for this type of haying. A mower, side-delivery rake, and forage harvester equipped with pick-up attachment can be used conveniently and economically. The same wagons and blower as used for green crops, provide the means for hauling and elevating the chopped hay into the barn.

Recent efforts in the development of lighter and more economically operated pick-up balers, likewise, are extremely promising and will probably be increasingly attractive to many individual users.

NEWS

The A.S.A.E. Fall Meeting

AS INDICATING the subjects to be featured on the program of the fall meeting of the American Society of Agricultural Engineers to be held at the LaSalle Hotel, Chicago, December 7 to 9, the following statement by Chairman Deane G. Carter of the A.S.A.E. Meetings Committee will be of particular interest to agricultural engineers and others interested in the program for the meeting.

"In recent weeks I have had the opportunity of examining the reports on agricultural engineering projects at the land-grant institutions that relate to the war effort. These together with the suggestions that have been received for the program of the A.S.A.E. fall meeting have revealed critical problems in each of the four main technical divisions of agricultural engineering activity.

"Government regulation and the necessity for certain restrictions and controls affect every agricultural engineering program, both in industry and in public service, including the emergency problem of crop storage, food production, alternative crops, and the materials to replace those of which there is a scarcity. The allocation of farm machinery and power units and the necessity for maximum conservation all along the line have affected the normal program in agricultural engineering.

"Also current events in a surprisingly large number of cases involve problems of an engineering nature.

"These conditions have had a major influence on the preparation of the program for the A.S.A.E. fall meeting. Not only is the Meetings Committee planning the whole program around problems associated with the war effort, but in each of the four main divisions of the Society the chairman is condensing and streamlining his part of the program to highlight the urgent, immediate, and effective procedures in the solution of wartime problems.

"It is my judgment that members of the Society can ill-afford to miss the three-day meeting in Chicago, December 7 to 9. As the program begins to take form it is certain that the problems of increased production, machinery rationing, conservation in all forms, new developments in agriculture and agricultural engineering, and adjustment of programs of maximum war contribution will be considered in and out of the formal sessions.

"The program is to be confined to a period of three days. All frills and entertainment features are to be omitted. So far as possible the sessions will be arranged so that members unable to attend the entire meeting may get the maximum professional benefit from two days or even from a single day if their time is extremely limited."

AGRICULTURAL ENGINEERING for November will carry a story of the program in final form, including scheduled subjects and speakers. Final printed programs will be available for distribution by November 10. Suggestions of subjects and speakers for the program or requests for information about the meeting should be addressed to the headquarters of the Society at St. Joseph, Michigan.

Farm Safety Program

THE subject of farm safety will be featured at two sessions of the 31st National Safety Congress and Exposition to be held at the Sherman Hotel, Chicago, October 27, 28, and 29. These two sessions will be held Tuesday forenoon and afternoon, October 27. The forenoon session will be devoted to a symposium on current developments in farm safety, in which three members of A.S.A.E. will participate, namely, Frank Kranick, J. I. Case Co.; E. W. Lehmann, University of Illinois; and V. S. Peterson, E. I. du Pont de Nemours & Co., who is also chairman of the A.S.A.E. Committee on Farm Safety.

A joint luncheon is being arranged for the same day for those attending the farm safety and the home safety sessions of the Congress. The speaker for the luncheon will be an A.S.A.E. member, Kirk Fox, editor of "Successful Farming," who will present reasons for home and farm safety work.

At the afternoon session V. S. Peterson will present a paper on the farm machine accident problem. This will be followed by a paper on safety for women and children in farm work by Miss Ruby M. Loper, extension agricultural engineer of Nebraska. The third and final paper of the session will be on meeting the shortage of physicians with first aid and accident prevention by Richard W. Thrush of the American Red Cross.

A.S.A.E. Meetings Calendar

December 7 to 9—Fall Meeting, LaSalle Hotel, Chicago

June 21 to 23—Annual Meeting, Purdue University, Lafayette, Ind.

In connection with the Safety Congress, arrangements are being made for a meeting of the A.S.A.E. Committee on Farm Safety at the LaSalle Hotel on Monday, October 26. Members of the Society, who are not members of the Committee, will be welcome to attend this meeting.

A Real "War Work Conference"

THE MEETING of the North Atlantic Section of the American Society of Agricultural Engineers, held at the Belmont Plaza Hotel, New York City, September 28 and 29, was in every sense a "war work conference." It was a fine example of the opportunity offered by such meetings to bring representatives of government agencies in Washington together with agricultural engineers from industry and from the land-grant institutions for a better understanding of problems connected with the war effort and for better coordination of ideas and efforts toward the winning of the war.

The meeting was also outstanding in the evidence furnished in every session of the fine contributions which agricultural engineers are making to the war effort.

During the business session of the meeting the following officers were elected for the ensuing year: Chairman, A. A. Stone, professor of rural engineering, State Institute of applied Agriculture, Farmingdale, Long Island, New York; F. M. Wigsten, rural service director, Central Hudson Gas & Electric Co., Poughkeepsie, New York; Secretary-Treasurer, R. J. Bugbee, agricultural engineer, Central Vermont Public Service Corp., Rutland, Vermont.

Shall Southern Ag Engineers Meet?

A JOINT meeting of the Southeast (formerly Southern) Section and the Southwest Section of the American Society of Agricultural Engineers was scheduled to be held in conjunction with the annual convention of the Association of Southern Agricultural Workers at New Orleans early in February 1943. (For a number of years the Southeast Section has met regularly at the time of the A.S.A.W. convention.)

However, both the membership and executive committee of the A.S.A.W. have voted not to hold the convention in 1943. The question for agricultural engineers of the South, by this action of the A.S.A.W., is whether they too shall cancel the meeting they had planned, or proceed with their plans to hold it just the same, and if so, when and where the meeting shall be held. Also, whether it shall be a joint meeting of the Southeast and Southwest Sections at some central point for members of the areas of both sections, or whether each section shall meet separately.

The annual meeting of the Society held at Milwaukee in June and the North Atlantic Section meeting held at New York last month proved to those who attended to be clearly worth while. Many new and pressing problems are confronting agricultural engineers in all sections of the country in these times.

(News continued on page 330)

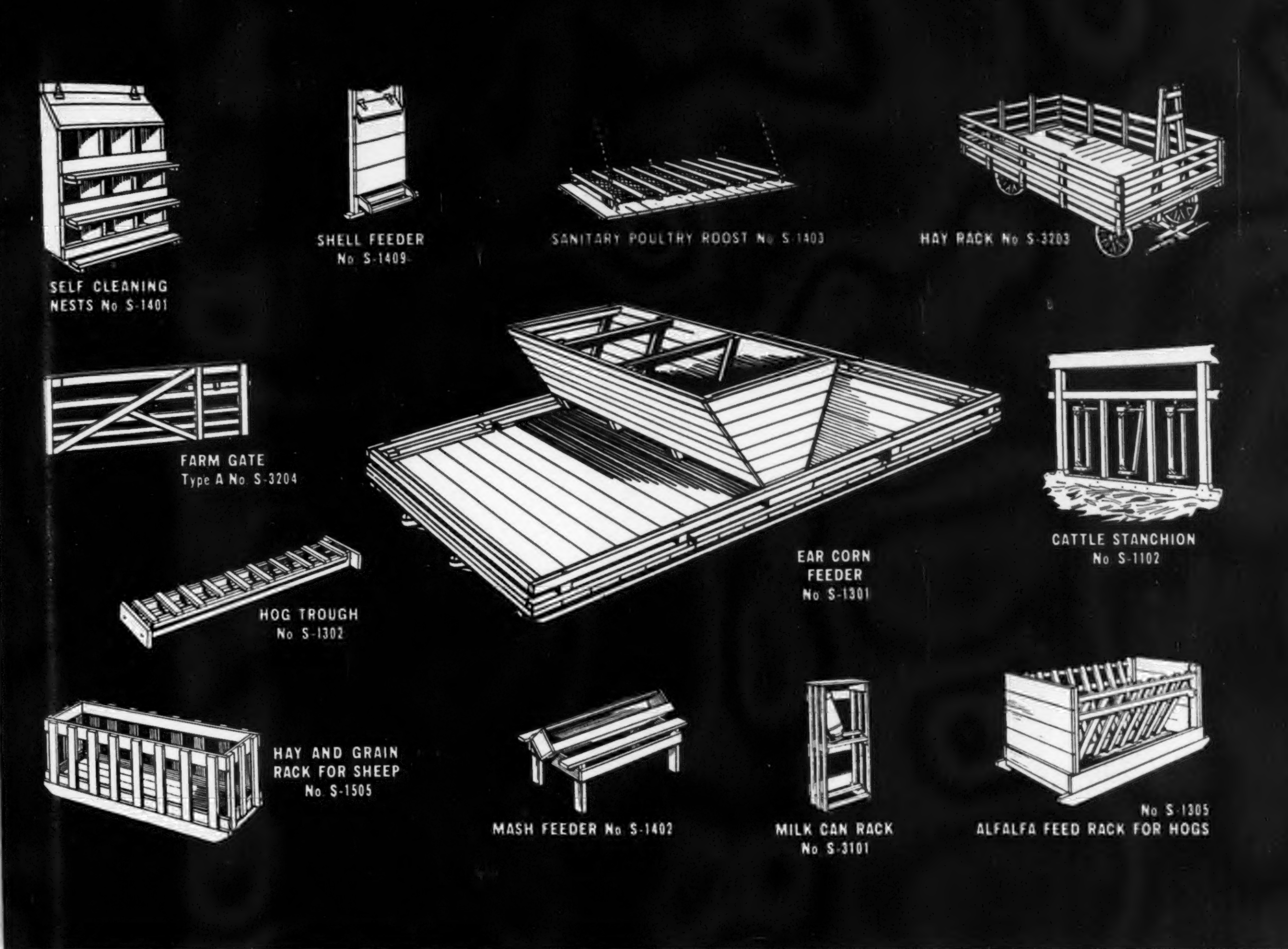
Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Raymond Goelbert, district manager, Detjen Corporation, 68-11 Kessell St., Forest Hills, N. Y.

George C. Marti, graduate trainee, General Electric Co., Schenectady, N. Y.

Samuel H. Yancey, chief designer, Cockshutt Plow Co., Brantford, Ont., Canada. (Mail) 192 Brant Ave.



Needed farm equipment now available through the wide adaptability of lumber...

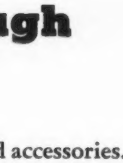
... despite the fact that the nation's tremendous demand for lumber has placed it on the list of critical materials and that the stocks of many dealers have been reduced.

Farmers can still get needed items of farm equipment for their fall and winter program, because of the wide adaptability of lumber—the interchangeability of sizes, species and grades.

Most items of farm equipment—self feeders for hogs, troughs, hoppers, alfalfa racks, self-cleaning nests, roosts, feed bunks, hayracks, gates, stanchions, can be made from smaller pieces of lumber stock—grades and species can be used interchangeably without seriously affecting the efficiency of the item. Accordingly, the present assortment of stocks in the majority of yards provides suitable lumber for the construction of fall and winter equipment and accessories.

Weyerhaeuser, working with agricultural engineers, has developed the 4-Square Farm Building Service. The latest addition to this service is a series of designs and plans for farm equipment and accessories that can be made from available lumber stocks. They bring to the farmer items that save feed, save labor and contribute to increased production. If you are interested in the new equipment section of 4-Square Farm Building Service, the book will be sent on request.

Lumber again demonstrates its value as the best and most economical material for farm construction. Buildings and equipment made of lumber can be easily and economically remodeled to serve a wide variety of farm needs.



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Personals of A.S.A.E. Members

Wallace Ashby is chief of the farm machinery and supplies section, division of War Board Services, U.S.D.A.

D. W. Cardwell, associate hydraulic engineer, U. S. Soil Conservation Service, stationed at Virginia Polytechnic Institute, is one of the authors of a bulletin, entitled "Farm Fish Ponds," recently issued by that institution.

Deane G. Carter, formerly head of the agricultural engineering department, University of Arkansas, and now professor of agricultural engineering, University of Illinois, is author of Bulletin No. 422, entitled "Investigations in Low-Cost Housing," recently issued by the former institution.

J. W. Crofoot, formerly assistant chief, has recently been made chief of the barn, poultry, and miscellaneous equipment section, farm machinery and equipment branch, War Production Board.

Elmer R. Daniel, formerly assistant extension agricultural engineer in Oklahoma, is now head of the plumbing unit in the Rural Electrification Administration, in charge of the field program.

E. M. Dieffenbach is now associate agricultural engineer, farm machinery and supplies section, division of War Board Services, U.S.D.A.

G. W. Giles, assistant professor of agricultural engineering, North Carolina State College, is one of the authors of a bulletin entitled "Farm Shop Activities and Equipment," recently issued by that institution. The bulletin is Bulletin No. 5 in the agricultural teachers' series.

John Heilman is now area specialist for the Farm Security Administration, USDA, at Lewisburg, Pa. In his work he is responsible for training district and county personnel in all phases of the FSA program, including farm management, cooperatives, debt adjustment, etc.

Paul R. Hoff, extension agricultural engineer, Cornell University is author of war emergency bulletin 28, "Lubrication of Farm Machinery", and one of the authors of war emergency bulletin 22, "Homebuilt Labor Savers for Poultry Keepers", both of which bulletins were recently issued by that institution.

A. T. Holman was recently appointed extension agricultural engineer by the Extension Service and the Bureau of Agricultural Chemistry and Engineering, USDA, to cooperate with the state extension services in dealing with agricultural engineering problems arising in connection with the food-for-freedom and other wartime programs. He will be available for consultation on ways in which the engineering facilities of the USDA can be used most advantageously and in the exchange of information between states as an aid in dealing most effectively with wartime farm problems. Mr. Holman has had twenty years of experience in agricultural engineering, including research, extension, and farm development work. He has been connected with the Department of Agriculture since 1931, his assignments including engineering investigations in soil erosion control, farm power and machinery investigations, farm housing studies, the investigation of agricultural engineering problems in Puerto Rico, and field supervision of farm operating efficiency investigations.

Leo E. Holman is now an associate agricultural engineer in the Division of Farm Structures, USDA Bureau of Agricultural Chemistry and Engineering, and is located at the BACE laboratory at Ames, Iowa. He was formerly extension agricultural engineer at North Dakota Agricultural College.

A. Clark Hudson, formerly an architectural designer in the U. S. Bureau of Agricultural Chemistry and Engineering, now holds a similar position with Chas. T. Main, Inc., architectural engineers, and is engaged in architectural design in connection with the Holston Ordnance Works.

C. M. Hummel, formerly a junior agricultural engineer in the U. S. Soil Conservation Service, is now civil engineer (chief of party) for Fraser-Brace Engineering Company, Kingsport, Tennessee, and is engaged in construction work on the Holston Ordnance works.

Arthur C. Jacquot, head, agricultural engineering department, Utah State Agricultural College, is author of bulletin No. 3, "Safety

(Continued on page 332)

Personals of A.S.A.E. Members

(Continued from page 330)

and Regulations of Electric Fence Controllers for Utah", recently issued by that institution.

B. A. Jennings, professor of agricultural engineering, Cornell University is author of war emergency bulletin 34, "Common Binder Troubles", recently issued by that institution.

George H. Larson, until recently a member of the agricultural engineering staff at the University of Wisconsin, is now a junior instructor at the Navy Teacher Training Center at Chicago and is engaged in teaching the subject of aircraft engines.

E. C. Lathrop, chief, agricultural residues division Northern Regional Research Laboratory, USDA, is one of the authors of a paper entitled "Straw for Industrial Use, Collection Problems and Quality," which was presented in February of this year before a meeting of the Technical Association of the Pulp and Paper Industry and published in the May 14 issue of "Paper Trade Journal."

Charles T. Male, Jr., has resigned as a member of the agricultural engineering staff at Cornell University to accept appointment on the engineering staff of Union College at Schenectady, New York. His new duties will be mainly in the field of civil engineering.

J. F. Mitchell recently accepted a position as chemical engineer with the Tennessee Copper Company, Copperhill, Tennessee. Prior to this he was junior agricultural engineer, Soil Conservation Service, USDA, located at Ardmore, Tennessee.

H. Seymour Pringle, according to a recent news release of the Office of Price Administration, is now heading up the agricultural and industrial machinery section of the newly created Standard Division of OPA. Mr. Pringle is now on leave from Cornell University where he is assistant professor and extension specialist in agricultural engineering.

H. S. Pringle, agricultural engineer, is author of war emergency bulletin 33, "Milking Machines, Washing and Care", recently issued by Cornell University.

Earl K. Rambo, extension agricultural engineer, University of Arkansas, is author of two recent bulletins published by that institution—extension plan series No. 1 "Homemade Storm and Storage Cellar" and extension plan series No. 2 "Homemade Peanut Picker".

L. H. Schoenleber, assistant professor of agricultural engineering, Kansas State College, is one of the authors of Extension Circular 158, entitled "Farm Garden Irrigation", just issued by that institution.

J. W. Simons, associate agricultural engineer, USDA Bureau of Agricultural Chemistry and Engineering, and *F. B. Lanham,* research agricultural engineer (now on military leave), University of Georgia, are joint authors of Technical Bulletin No. 822, entitled "Factors Affecting Temperatures in Southern Farm Houses", recently issued by the U. S. Department of Agriculture.

Ira L. Williams, lately instructor in rural engineering, New York State Institute of Applied Agriculture, is now an assistant agricultural engineer with the U. S. Soil Conservation Service, engaged in farm and ranch soil and moisture conservation planning, and is located at Stanton, Texas.

F. B. Wright, assistant professor of agricultural engineering, is author of war emergency bulletins 26 and 29, "Fire Prevention on Farms", and "How to Put Out a Fire", respectively, recently issued by Cornell University.

New Literature

"Introduction to Agricultural Engineering," by Harold E. Pinches (Member ASAE), head, agricultural engineering department, University of Connecticut. Second edition. Paper, $8\frac{1}{2}$x$10\frac{3}{4}$ inches, 90 pages, 60 figures. $2.00. H. E. Pinches, Storrs, Conn.

This book has grown out of the author's experience in teaching a number of courses in agricultural engineering in the various and somewhat diverse fields combined in the profession. As a result of this experience, he found a common body of knowledge

(Continued on page 336)

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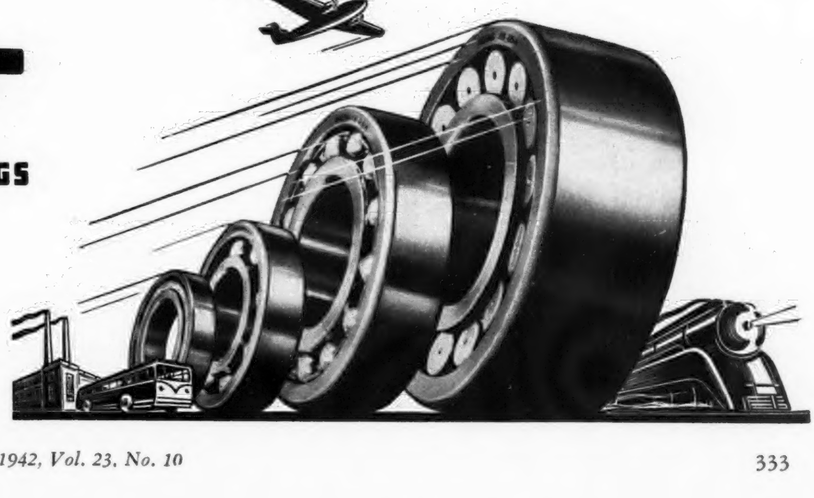

New Literature

(*Continued from page 332*)

and basic principles more or less running throughout the whole field of agricultural engineering, and he has gathered this material together so that it may be used as a background for more specialized courses.

Recognizing that agricultural students generally have a limited preparation and understanding of physics, the text devotes considerable space to physical principles, the purpose of which is not so much to teach physics as to bring out the practical application of certain fundamental principles. The text has been developed to meet the need of the large body of agricultural students who take a major in some other field and who may take one or more courses in agricultural engineering, but it is not intended as an introduction to agricultural engineering on the professional level.

The approach of the book is analytical, attempting to show methods of thinking and to provide a preliminary acquaintance with a wide variety of problems, and it is the author's hope that an interest may be aroused and the ground work laid from which the student can proceed to more penetrating and independent application of certain fundamental physical principles to problems of agricultural industry and rural living.

The book is divided into two parts. Part I, "Force Relations," contains chapters on what forces are and how they act; the action of external forces on bodies, including the effect of off-center forces; the action of internal forces (strength of materials), and the balancing of external and internal forces (proper use of materials in structures). Part II deals with energy states and transformations, and includes chapters on power and work, power and machinery in agriculture, heat (including cooling and refrigeration, thermal conductivity and insulation, and air conditioning), electricity in agriculture, hydraulics (including energy relations of water control and water systems), and levels and leveling.

"FARM MACHINERY," by Archie A. Stone (Member ASAE), head, department of rural engineering, New York State Institute of Applied Agriculture (Farmingdale). Third edition. Cloth, 6x9 inches, 524 pages, 365 figures. $3.25. John Wiley & Sons, New York.

This edition has been revised and corrected, and new material has been added, but the same practical methods of study found in previous editions have been retained — methods designed to meet the needs of men who have definite tasks to perform. In the preparation of this book careful thought has been given to the needs of pupils preparing for specific farming occupations. The problem attitude has been maintained throughout. "Shop jobs" are organized so as to stimulate interest in the actual study of machinery problems and to give specific directions for conducting the work in an orderly manner. By these devices and by the inclusion in each chapter of contents regarding machinery types, parts, and adjustments, it is believed vocational pupils will be assisted in acquiring the abilities necessary to maintain and repair farm machinery. Main chapter headings include the following: Plows; Harrows; Grain-Seeding Machines; Row-Crop Seeders and Planters; Cultivators; Mowers; Grain Binders; Fertilizer-Distributing Implements; Threshers and Combines; Potato Planters and Diggers; Tractors; Tractor Engines; Carburetion System; Ignition System; Cooling Systems; Transmission Systems; Front Axle, Front Wheels, and Steering Gear; and Operation and Maintenance.

"WEED CONTROL," by W. W. Robbins, A. S. Crafts, and R. N. Raynor, botanists, California Agricultural Experiment Station. First edition. Cloth, 6x9 inches, 518 pages, 202 figures. $5.00. The McGraw-Hill Book Company, Inc., New York.

This book gives a critical review of the various methods of weed control, including the results of recent investigations. There is an adequate treatment of weed production and dissemination of weeds, competition between crop plants and weeds, and association of weeds with soil and crops. The main emphasis is on practical weed control methods, their uses and limitation. The main chapter headings cover the following subjects: Weeds and Human Affairs; Reproduction of Weeds; Association of Weeds with Soils and Crops; Methods of Preventing the Introduction and Spread of Weeds; Principles of Weed Control; Tillage Methods of Weed Control; Competition between Crop Plants and Weeds; Biological Control of Weeds; The Use of Chemicals in Weed Control; Nonselective Contact Sprays; Selective Herbicides; Translocated Sprays; Chemical Soil Sterilization; Temporary Soil Sterilants of a Volatile Nature; Sodium Chlorate as a Temporary Soil Sterilant; Boron Compounds, Arsenic Compounds, Thiocyanates, and other Soil Sterilants; A Comparison of Soil Sterilants; Combinations of Herbicides; Comparison and Application of Weed-Control Methods; Machinery for Applying Herbicides; Special Weed Problems in Grasslands and Turf, Cropped Areas, and Uncropped Areas; and Special Weeds.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DESIGN ENGINEER capable of original design of farm machinery and related lines, or a man capable of developing into a real design engineer, is wanted by a well-known manufacturer of farm machinery and other equipment. Persons interested are requested to write giving full particulars regarding technical training and experience and other pertinent information. PO-140

GRADUATE ASSISTANTSHIP open in the Pacific Northwest; may be used in the field of farm structures, farm machinery, farm power, rural electrification, or land development. This fellowship provides a stipend of $450 a year on a 9-month basis, requiring about one-third the student's time for teaching and laboratory assistance in elementary engineering subjects. It may be used over a 2-year period for graduate study leading to a master of science degree in agricultural engineering. Applicants should write Hobart Beresford, head, agricultural engineering department, University of Idaho, Moscow.

AGRICULTURAL ENGINEER wanted to fill position offering $2100 to $2500 per annum for duration of war. Combined teaching and research in agricultural engineering in the field of farm structures, graphic presentation, storage, refrigeration, and related subjects is covered by the opening. Applicants should submit with first letter complete personal record with recent photograph to Hobart Beresford, head, department of agricultural engineering, University of Idaho, Moscow.

TRACTOR SALES MANAGER wanted. State distributor for a leading make of farm tractor and implements wants an experienced executive who is qualified to head up sales and service activities. Must have proved sales record, aggressive sales ideas, and a knowledge of farming and its problems. Salary and bonus above average to right man. Write in confidence for application. PO-139

AGRICULTURAL ENGINEER wanted to fill position open in northeastern university due to absence of staff member in military service. Work involves approximately half extension and half resident instruction. Major concentration in farm structures and soil and water conservation. Salary up to $3000 for qualified person. PO-137

CIVILIAN ENGINEERS qualified for work in mining, metallurgical, electrical, radio, structural, sanitary, mechanical, and materials engineering, are needed by the federal government for appointment to many war agencies. Most of the positions pay from $2,600 to $3,800 a year. A few positions exist at higher salaries. Applications for these positions are obtainable at first and second-class post offices throughout the country and should be forwarded at once to the Civil Service Commission in Washington, D. C.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. S. degree in agricultural engineering from Iowa State College. Has four years' experience as engineer with the Soil Conservation Service and five years' experience as state agricultural conservation engineer for the Agricultural Adjustment Administration. Experienced both in engineering and administration. Thirty-two years of age, married, and have family. References upon request. PW-348

AGRICULTURAL ENGINEER with B. S. degree in engineering and M. S. degree in agricultural engineering. Experienced in college teaching, experiment station, and extension work; also factory and construction work. Especially qualified for college agricultural engineering, manufacturing, defense, construction, or trade extension work. Age above draft. PW-346